I. C. Russell

THE

GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

THE THIRTEENTH ANNUAL REPORT,

FOR THE YEAR 1884.

N. H. WINCHELL, STATE GEOLOGIST.

Submitted to the President of the University, April 1, 1885.

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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN., April 1, 1885.

To the President of the University,

DEAR SIR: I have the honor to present herewith the thirteenth annual report on the geological and natural history survey. Accompanying this is a copy of the second annual report for reprint, as that report is constantly requested by librarians and geologists who desire to complete their series, and has been out of print for several years.

Very respectfully, your obedient servant,

N. H. WINCHELL,
State geologist and curator of the general museum.

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REPORT.

I.

SUMMARY STATEMENT.

An edition of six hundred copies of the first volume of the final report of the survey was bound and distributed prior to December 1st. If the number bound and ready for distribution had been much larger the edition would have been exhausted immediately. The distribution was made in accordance with the instructions of the secretary of state, as expressed in the following circular, but the number of copies was not large enough to supply all the libraries and institutions contemplated by the instructions:

RULES OF THE SECRETARY OF STATE FOR THE DISTRIBUTION OF THE FINAL REPORT OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

In February, 1881, a bill was introduced in the state senate by Hon. J. B. Gilfillan, which had sundry provisions concerning the printing and distribution of the volumes of the final report of the state geologist on the geological and natural history survey of the state. Although this bill passed the senate it was lost in the house in the last days of the session, from lack of time. It is presumed that had it came to a vote in the house it would have passed, as it was approved unanimously by the senate. It has therefore been adopted and followed as far as possible, in the publication of the first volume of the survey, and

will be in the future, unless the legislature orders otherwise. Section four of this bill reads as follows:

"SEC. 4. The volumes of the final report of said survey, as they may be prepared by the state geologist from time to time, shall be issued in an edition of five thousand copies each, and shall be distributed in the name of the board of regents of the University, under the direction of the state geologist, to scientific and educational institutions, and to individuals as follows:

"To the library of each chartered college and scientific institution in Minnesota, three copies each; to each normal school, three copies; to the libraries of the institute for the deaf and mute, the insane asylums, the state prison, and every public library in the state, not otherwise designated, one copy each; to each county auditor for the use of the county, one copy; to each of the offices in the capitol, one copy; to each member of the board of regents, three copies; to the Historical Society, and to the Minnesota Academy of Sciences, ten copies each; to each newspaper published in the state, one copy; to each senator and representative of the present Legislature, one copy; to the governor and lieutenant governor, each one copy; to each assistant on the survey, who has furnished manuscript or illustrations published in the report, three copies; to other scientists in Minnesota, fifty copies; to the general office of each railroad that has furnished aid to the survey, three copies; to the library of each high school, furnishing students fitted for the freshman class of the State University, one copy; to the state library of each state in the Union, one copy; to each state university and college of agriculture and mechanic arts, one copy; to the geologists and naturalists of other states, two hundred copies; to the library of the University of Minnesota, two hundred copies; to other colleges and scientific institutions in the United States, one hundred copies; to foreign institutions and scientists, one hundred copies; and to the state geologist, twenty-five copies. The remainder shall be deposited in the State University, and shall be sold at such prices as the board of regents may determine; and the proceeds of such sales shall be used by said regents for the purchase of apparatus and books for the survey, and after its completion, for the departments of natural science at the State University."

The only departures from the foregoing, ordered by the secretary of state, consist in the delivery of two hundred copies to

the secretary of state, for distribution to the offices of foreign consuls, and the transmission of the proceeds of all sales to the state treasurer at St. Paul.

The copies remaining after this distribution will be sold at five dollars per copy for the best style, (tinted paper, half roan binding,) and three and a half dollars for the common style, bound in cloth, according to the direction of the executive committee of the board of regents, approved by the secretary of state.

All correspondence should be addressed to

N. H. WINCHELL,
State geologist,
Minneapolis, Minn.

Unless the Legislature orders otherwise it is probable that the rest of the edition, when bound, will be disposed of according to this plan.

From the last week in September to the end of the year the time and energy of the survey was given almost entirely to the work of preparing a suitable exhibit at the World's Cotton and Industrial Exposition at New Orleans. A portion of the accompanying report consists of a description of that exhibit, as prepared, with the permission of the board of regents, under the direction, and mainly at the expense of the Minnesota State Board of Collective Exhibits. From December 1st till January 11th, I was in New Orleans, occupied with the installation of this exhibit. Mr. Upham was also absent on the same work from December 1st till Christmas, and my son H. V. Winchell, who had been casually and temporarily occupied throughout the summer in laboratory and office work of the survey, and continually through the fall on the New Orleans exhibit, was left as permanent custodian of the property. The aggregate value of the articles belonging to this portion of the Minnesota exhibit is about six thousand dollars, as estimated for the placing of insurance.

Mr. C. L. Herrick who was at work on the mammals of the state, and had spent about a year in making original observations thereon, was appointed to a position on the faculty of Denison University, in the state of Ohio, and was released during the fall, and till January 1, 1885, to discharge those duties. He has now, however, resumed work, and will render his final report on this branch of the natural history of the state before the close of the year 1885.

Dr. P. L. Hatch's report on ornithology has not yet been tendered, but it is expected that it will be ready for publication in the early part of the present year.

In order to complete the publication of material already on hand, relating to the geology proper, provision ought to be made, during the legislative session of 1885, for the printing of another volume. This would be largely devoted to a belt of counties in the central portion of the state, and would be of scope and plan similar to volume one.

At the World's Industrial and Cotton Centennial Exposition, now being held at New Orleans, the State of Minnesota for the first time publicly exhibits two new products of her natural resources—salt and iron.

The brine derived from the well at Humbolt, in Kittson county, is an augury of what may be in the future. The brine which overflows at the surface has more than the average per cent of chloride of sodium found in the Michigan brines, while the total solid matter in solution (including chloride of sodium) is only from one-third to one-half as much. The probable geological formation from which this brine issues and the conditions of future successful exploration, are given in the accompanying report. I have to acknowledge the generous assistance of Mr. Valentine, owner of the well, for valuable information and for a series of the drillings from the well.

The year 1884 has witnessed a very extensive and important opening of the iron mines at Vermilion lake. Mr. George C. Stone, of St. Paul, general manager for the Minnesota Iron Company, has given every facility for the examination of the mines, and has supplied information and statistics embraced in the chapter on the Vermilion iron ores. Specimens illustrating the ores of the various mines at Vermilion lake are on exhibition at New Orleans, aggregating in weight about 2,500 pounds. Sixty-two thousand tons were shipped from the mines in the latter part of the season, delivered at Cleveland, Pittsburg and other lower lake ports. This ore ranks well, so far as assays made at the mines indicate, with the ores of the best quality from Michigan. It is believed to be derived from rocks of the same geological horizon as the ores from Marquette and Menominee.

The importance of this development to the state of Minnesota can hardly be overestimated. This is the most westerly point at which the ores of this geological horizon are known to exist. They should not be carried east for smelting and manu-

facture, but should be reduced where they are mined. Their market will for the present be in the east, but their ultimate consumption will be in the west where the settlement and rapid development of the country demand iron for all the appliances into which iron enters. The freightage of the manufactured products directly from Minnesota to supply this western demand will ultimately be seen to be so much cheaper than the carriage of the ores east and the manufactured articles again west, that the ways and means for avoiding this double freightage will be sought and found by the shrewd capitalists of the state. Such articles would compete successfully, in the western markets, with those of eastern manufacture. The coal of Iowa or Illinois would have to take the place of that of Pennsylvania, unless charcoal could be substituted.

II.

RECONNAISSANCES.

(*a*). *Notes of a reconnaissance into Pope county, May*, 1884.

This trip of observation was made at the instance and solicitation of Mr. G. Tharaldson, of Langhei.

The drift. Along the new railroad extending northwestwardly from Minneapolis to St. Cloud are various new and interesting exposures of the drift deposits, which deserve a careful inspection. They exhibit the relations of the gray and red tills, the gray overlying the red and finally prevailing entirely. There are also gravel deposits, and patches of laminated clay. Northwest of this moraine the surface is flat. At once this flat tract is seen to consist of gravel derived from the gray till, containing Cretaceous bits. At Rodgers Siding the country is timbered, and undulating, the till being gray, and very fine.

At the crossing of Crow river the gray till becomes converted into and overlain by a pebbly clay, and then by a finer loess, which last shows ten to fifteen feet in thickness at the first (outer) cuts. There is some gravel and sand considerably tinted with red, indicating the proximity of red till deposits. At a few points a red till is seen at the lower levels. After crossing the river the country is timbered and rolling for about two miles, but the surface consists of this loess, or fine silt without boulders. It then becomes flat or undulating, and the soil rather sandy, though probably a till, and occasionally is red, but mainly gray— especially gray in the upward swells and ridges that are cut by the grade.

Monticello is on a gravel plain but few feet above the river, which is apparently analogous to, if not identical with that on

which St. Cloud is situated, though at the latter point it is apparently about two miles in width.

Red granite is to be seen near the railroad bridge over the Sauk river, near St. Cloud. On crossing the river the grade ascends, apparently, to a higher flat than the St. Cloud flat, which likewise consists of gravel—at least there is no bluff on the east side, but the road runs from the plain directly on to the bridge which is about fifteen feet above the water, while on the west side it enters cuts in gravel bluffs about fifteen feet higher than the grade. With some undulations this gravelly flat continues to St. Joseph, the railroad cuts only showing gravel.

West from St. Joseph the surface becomes broken and rolling, yet consists of gravel. This gravel, however, in the distance of about a mile from Watab creek, in the direction of the railroad, gives place to a red till, even morainic till on the east side, and then also on the west side. This is the condition of the surface at Collegeville. This red till becomes yellowish, verging toward gray, interspersed with tamarack swamps. As a red till, however, it apparently continues to Avon, and to Albany, but with variations to a yellowish color. Just west of Albany a characteristic gray till appears, lying over the red, but is rather pebbly instead of stony, and the surface becomes smooth or gently undulating, and continues so to Freeport. At Melrose this gray till is covered by a loess loam, due apparently, to the former action of Sauk river in the valley of which Melrose is situated. At the crossing of Sauk river, west of Melrose, the bluff cut consists of gray till, 15 feet.

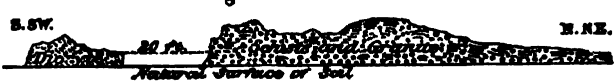
At Sauk Centre, on the diorite rock, situated about half a mile southeast from the railroad station, the glaciation runs 42° east of south (true meridian).

Crystalline rocks at Sauk Centre. This is a dark speckled rock consisting almost entirely of hornblende and feldspar, the relations of which to the red granite lying adjacent, are hid by drift. The red granite is about 20 feet distant (north) from the dioryte. The dioryte resembles that at "the point," at Little Falls, in having, over part of its upper surface, where planed by glaciation, the alternating lines of predominating feldspar with predominating hornblende, causing an appearance as of lamination, or at least a coarse gneissic structure. Except this, and some jointage planes, it is homogeneous and massive, and is exposed over an area of about a square rod. At several places, extending for forty rods further southeast, on land of Mr. Gates, this

dioryte is found in outcrop, and has been quarried. It is here a jointed, angular, firm rock, the same as at the point on Mr. Carl's land, described. It shows milky-opaque quartz, visible to the unaided eye, though no quartz can be thus discerned in it at Mr. Carl's. It disintegrates more rapidly than the granite. While it appears, in bulk, massive, it has frequent joints running in all directions, facilitating the rude methods of quarrying that have been pursued. The outward aspect of the general surface is much like that of some disintegrated portions of the Duluth gabbro range.

The adjacent red granite, which might be called gneiss, has about ten times as much area of exposed surface as the foregoing. It encloses bands and patches of mica schist. It has an abundance of evident quartz, and some of the orthoclase crystals are two and a half inches in diameter, especially when, somewhat in the manner of veins, the red granite interpenetrates and cuts across, the schists. Sometimes it runs in vanishing narrow seams coincident with the schistose direction, and sometimes it cuts boldly across it, the schists then having apparently an angular, fractured termination. This mica schist is firm, quartzose, and occasionally green as if with epidote, and would, in many places, properly be styled a gneiss. Its structure runs 60° east of north (true mer.), and is nearly vertical, but in some cases is at a small angle (two or three degrees) with a perpendicular, the dip being toward the south. At another point this structure, which stands about vertical, runs north, 88° east (true mer.). It is here disturbed by a network of veins of the red granite, and becomes exceedingly firm and dark colored, being really a dark gneiss. In the most of this mica schist hornblende is more abundant than mica, the former constituting the bulk of the dark ingredient, and the latter appearing at the planes of easy separation.

Fig. 1.



It is only in the southern part of this red granite that it has any involved dark schists or gneiss, and the nearest part is twenty feet from the foregoing dioryte. If there be a superposition, as indicated by the slope of the upper surfaces, the dioryte lies under the granite. (See figure 1.)

No. 858. Average sample of the red granite.
No. 859. Average sample of the hard, dark schist, or gneiss.
No. 860. A sample of the schist showing considerable mica.
No. 861. Average sample of the massive dioryte.

At another small area of exposed red granite about thirty rods further northwest, the enclosed area of schist strikes east and west, and dips toward the south, at an angle of about 15° from a perpendicular. Here also the general slope of the outcrop is a glaciated dome with a gentle slope toward the north-northeast, and a steep one west-southwest, rising about two and a half feet. At several places in the village, and especially on the land of Mr. Carl, the rock is found but few feet under the surface.

Mr. Carl sells stone at one dollar per cord, and lets the quarry to parties who work it. They sell for eight or ten dollars per cord.

Flouring mills at Sauk Centre. The *McClure Roller Mills* are owned by the McClure estate, and are run by water power in Sauk river. The fall is 11½ feet, aided by a dam which sets water back several miles. The mills have two Kindelberger wheels, of 48 and 35 inches diameter, producing respectively about 68 and 40 horse power. There are six sets of corrugated (Noye) rollers, and three sets of smooth rolls, with two stone buhrs for flour; the capacity of the mills being 175 barrels in 24 hours.

Artificial mounds. Near the county line between Stearns and Pope counties, along the valley of Ashley creek, are a great many artificial mounds of earth. They are on the north side of the railroad accompanying a marshy tract. The railroad passes up an old valley of glacial drainage, abundantly strewn with gravel, and these mounds are frequent along this valley. Near a school house in the valley granite outcrops are visible. This is a short distance east of Westport, and where Ashley creek receives a tributary from the south. There is another more remarkable mound situated at the point where the railroad passes between lakes Amelia and Turtle, at the western extremity of the gravel ridge on which the railroad runs between the lakes; which is so large that it can hardly be artificial. Indeed it appears more like a flat-topped remnant of an old terrace. It rises about 20 feet above the lakes, and about 15 feet above the rest of the country. It is on the north side of the railroad, and about three-fourths of a mile in diameter.

Twenty or more other artificial mounds are on the land of Dan.

F. Bartke, S. W. ¼ sec. 2, T. 125, 38, a short distance west of Glenwood. One in this vicinity is known as *White Bear mound.* This rises about 200 feet above the lake, but is situated on a natural conical hill. This is on the north side of the lake, about three miles from Glenwood. Numerous other mounds are on the low land, southwest of the White Bear mound, on the north side of Pelican lake; also north of White Bear mound, and northwesterly, scattered over the upland prairie.

Minnewaska lake. This lake, according to statements of citizens of Glenwood, was originally designated by an Indian name, meaning *Dish lake,* because of its being in a low basin. After that, when the chief, White Bear, was buried in a high hill on the north shore, it was called *White Bear lake.* After a time it was changed to *lake Whipple,* from bishop Whipple, of Faribault, and by act of the state Legislature of 1883 it was again changed to *Minnewaska,* or Good-water. It is said to be 85 feet deep in its deepest part, and averages about forty feet, and there is no known evidence of its having ever stood at a higher level.

This lake basin, which is also known, facetiously, as the "Pope county cellar," seems, to one approaching it from the east by way of the St. Paul, Minneapolis and Manitoba Railway, as he first views it from the railroad station, like some grand excavation in the rocky formation of the country. The smooth, high prairie, which, as a gravel-strewn plain, extends monotonously northeastward from the east end of the lake, breaks off rather suddenly toward the west in a remarkable depression of about 240 feet, and in this depression the expanse of the lake appears. There has been discovered, however, no rock bed in any of its bluffs, which consist, everywhere, of drift materials only.

A limestone mass, lying among the drift hills N. E. ¼ sec. 18, T. 125, 37, owned by Mrs. Sarah Peterson, in the upper part of the bluffs that enclose the lake, was suspected to be an outcrop of the native beds, and was so reputed. It was carefully examined. Its strata are nearly horizontal dipping N. W. about 2 degrees, and on excavation in front it maintains a perpendicular face as far as dug, developing a thickness of at least 5½ feet. With a probe it was found to run under the soil, southward, about 9 feet., but beyond that the probe passes too deep without striking it to allow of its being continuous *in situ.* On lower ground, in the vicinity of this limestone mass, are several large boulders of coarse, red granite, some being ten feet in diameter. About the shores of the lake are occasionally found bits of Cretaceous

lignite. It was stated that one man found a piece as large as he could carry. It *seems* to come from below the water, since it is said to appear after heavy storms.

The drift bluffs at the east end of the lake, have an average hight, as measured by aneroid, of 248 feet above the level of the lake, but some of the hills adjacent rise about 25 feet higher. These hills, and the general flat surface extending northeastwardly, are composed superficially, and largely of gravel and sand. The effect of winds and storms on this deposit has been to uncover and make superficial numerous transported boulders, especially throughout that part which has a broken contour. Thus the apparent abundance of boulders, large as it is in the original, in comparison with that of boulders in ordinary till, is superficially much increased. They are innumerable, some of them being two or three feet in diameter. In some places they literally cover the surface with a continuous pavement. These bluffs appear rough and hilly just at the lake, and between the station and the lake. From their summits the prairie level, flat or moderately undulating, is maintained eastward; but toward the northwest the surface is rough and stony, exhibiting the characters of a glacial moraine, extending to the south of lake Reno.

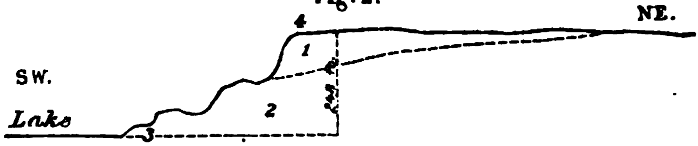
Below this covering of gray gravel, which seems to be 50 to 75 feet thick, these bluffs are composed of gray till. This is evinced by the composition of exposed cuts and slides in the frequent ravines. This underlying till sheds the water that penetrates downward in the gravel, causing numerous springs which are found at about the same horizon in the bluffs, all about the east end of the lake. The spring waters gather into little creeks, and one of these was caused to run a small flouring mill till a few years ago. The village of Glenwood is supplied with excellent water by a pipe running beneath the surface of the ground from an artificial reservoir in which several of these springs are concentrated, one hundred and forty feet above the village. The resultant pressure is sufficient to throw a stream from the hydrants in the streets, over any of the houses of the village.

The high bluffs which appear at the east end of the lake are not so conspicuous further west. They insensibly diminish, and descend finally to the "outlet," where the general level is but a few feet higher than the lake itself. In the same manner the south shore descends toward the west.

Between the tops of the hills, at the railroad station, and the

undulating or rolling surface on which Glenwood village is situated, a distance of about a mile, are curious knolls, more or less elongated, of gray, or yellow, till, rising in the midst of a general till area. The general contour of the bluff at the east end of this lake is shown by figure 2.

Fig. 2.



Explanation of Figure 2.

1. Gray gravel and sand, with many stones and boulders.
2. Yellow till, with few stones and boulders.
3. Place of Glenwood village.
4. Place of Glenwood station.

The moraine which passes along the east end of lake Minnewaska is from one-half to three-quarter mile distant from the lake, and extends N. W. from Glenwood. It is characterized, at one and two miles north of the station, by more numerous granite boulders, strewn over the tops of the knolls, among them being some of limestone. The country three miles northwest is rough, even very rough, some of the hillocks rising 100 feet higher than the station. Lake Reno is said to be forty feet higher than the railroad station at Glenwood. East from the station the surface becomes smooth, but shows a very slight eastward decline, for at least a distance of about two miles. From Glenwood the line seems to pass more southerly, into Barsness.

Springs. Allusion has already been made to the singular and persistent spring-course along these bluffs, reminding the beholder of the similar effect of the green shales of the Trenton in Fillmore and other counties in forming a line of springs near the tops of the St. Peter bluffs in those counties.* These springs afford a strongly calcareous water, and in favorable positions deposit a copious sediment of tufa. Such deposits are found on S. W. ¼ sec. 2, T. 125, 38, on the land of Daniel F. Bartke, and on that of Stillman Ayers. It is here deposited on growing moss and leaves, and lies at 100 to 150 feet above the lake. The water is shed by the underlying clayey till. In similar circumstances

*Final report, vol. 1, p. 274.

are found local beds of peat, maintained on the face of the bluff below such springs. Some of the water, on flowing again through the bog becomes sulphuretted, and similar to that of Mr. Bryan near Minnesota City, in Winona county.

Another source of springs, apparently below the clay, gives chalybeate water. This source gives origin to the springs that issue at much lower levels along some of the larger creeks that cut the bluffs in the same vicinity. They are distinct from the lime-depositing springs.

Brick are made at Glenwood by John Aiton. They are of a light red, or yellow-red color, and sell for ten dollars per thousand. Mr. Aiton also burns quicklime, from boulders gathered on the surface.

Mills. There are three mills on the Chippewa that serve the farmers of southeastern Pope county, viz.: *Swift Falls mill*, Marlue mill and West's mill. The first is a roller mill, but the others are stone mills, with three run in each.

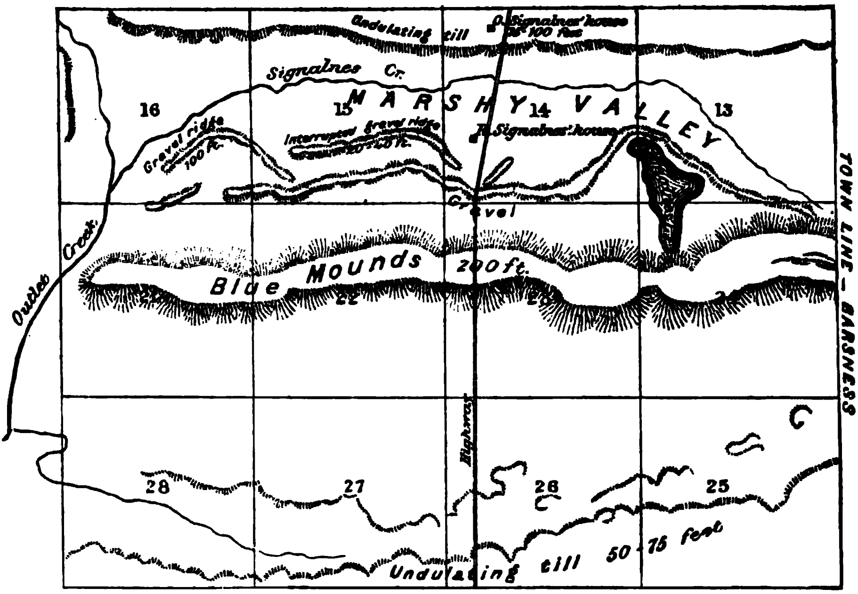
Trees. The native trees of southern Pope county are as follows: Bur oak, bass, elm, ironwood, aspen, white ash, plum, box-elder, willow, sugar maple, balm of Gilead (in Langhei), black ash, juneberry, red elm, cottonwood, black cherry, hackberry — no black oak, nor white oak.

The Blue Mounds, a remarkable ridge of drift materials running through the southern portions of Blue Mounds and Barsness townships, a portion of which is illustrated by the accompanying sketch-map (Fig. 3) has been described by Mr. Upham in the eighth annual report.* This ridge, where sketched, consists essentially of the coarser drift materials, gravel and sand predominating, overstrewn and intermingled with boulders. The pebbles are some of them from the Cupriferous, such as dark amygdaloids, melaphyr, epidote and quartz, and numerous greenstones. But the most of the larger stones are granite and hornblendic schists, with Winnipeg limestone. The bulk of the entire range seems to be gravel and sand, as evinced by the great depth of some of the depressions which only rarely contain any water and by little cuts along the roadside. It is a distinct, and almost a simple, range. Along its north side in the valley of Signalnes creek it is flanked by a subordinate parallel range rising about half as high as the main range. This range is also composed of gravel and sand. It is interrupted, sometimes

* Eight report, p. 78.

double, and presents all the characters of a glacial kame. It runs into and blends with the main range on the town line of Barsness, where it seems to contribute its contents to that range, causing the highest point in the whole series, so far as seen, in this vicinity. Toward the west the Blue Mounds are lost in crossing

Fig. 3.



the valley of Outlet creek, or the valley which Signalnes creek occupies, for Outlet creek comes through drift, and has approximate bluffs till it enters the Signalnes valley.

On each side of the Blue Mounds range is a distinct valley, that on the north side being bounded abruptly on the north by a bench or bluff of till, rising from 75 to a 100 feet. That on the south is also bounded on the south by an undulating ascent of gray till, which, within a quarter of a mile, reaches the height of 50 to 75 feet above the valley. The northern valley is occupied by Signalnes creek, but the southern valley has no distinct line of superficial drainage except at its western termination where, through section 28, a little creek is formed which works westwardly toward lake Emily. The ridge itself, where crossed by the highway in section 23, is not more that 80 rods across, and its hight is about 200 feet.

Toward the south further the till surface continues to rise, and becomes approximately flat or smoothly undulating, within a mile. In section 1, Langhei, next the Rolling Fork township line, the elevation is 1,347 feet, as determined by aneroid under favorable circumstances, the connection being made with Benson station which is 1,042 feet above mean tide.

From the high land in Langhei the "blue mounds" appear lower than the moraine at Glenwood, and with a glass the former can be seen running along eastward into Barsness as an isolated single ridge, the distant moraine being seen over it.

According to Mr. G. Thasaldson the Blue Mounds consist entirely of sand at the point where the highway from Glenwood to Benson crosses them, which is about three miles east of the point above described. The same was stated by Mr. Signalnes. Mr. Upham also describes mount Tom, in Colfax, Kandiyohi county, as composed of coarse drift materials, largely gravel and sand, this hill being in the supposed eastward extension of the "blue mounds."

As to the origin and nature of this ridge of gravel and sand, it presents all the characters of a glacial kame; but its gigantic proportions, if of that nature, would make it rank among the largest ever described in this country, since, according to Mr. Upham, it can be traced distinctly for a distance of about forty miles. Mr. Upham has, besides, regarded it rather as a terminal moraine, produced by ice moving in a northeasterly direction. While it seems necessary to give this ridge further examination, with special reference to the nature of its contents, its actual width, continuity and location, before its origin can be considered understood, there are some surrounding facts, and theoretical considerations, which indicate strongly that this range of drift hills is more of the nature of a kame, due to the action of an immense glacial river, in glacial times, than of that of a terminal moraine formed by glacier ice. The same facts and considerations would also indicate that the "Dovre moraine," in Kandiyohi county, is another great kame of gravel and sand.

The flat country at Benson, which is sandy and rather poor for wheat, extends several miles in width east and west. It is due to the former action of the Chippewa river, which now runs but little below the general level, and which formerly must have spread widely over the country, spreading sand and sandy clay. This sandy loam is twenty-two feet thick at Benson. All wells get water at the bottom of it, on the clay.

(*b*) *Notes of a trip across the Mesabi range to Vermilion lake.*

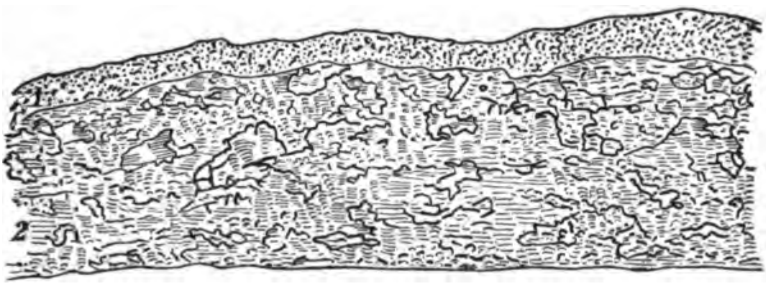
This excursion was made for the purpose of obtaining samples of the Vermilion ore, for exhibition at the World's Industrial and Cotton Centennial Exposition, at New Orleans. A few observations of geological interest were also made.

Surface features. First—There are two belts of morainic accumulations noticeable between the lake Superior shore and Vermilion lake. One is south of the crossing of the Cloquet river, about twenty miles from Two Harbors (Agate bay, of the previous reports); the second is from two to five miles north of the crossing of the St. Louis river. This is remarkable, not for the hight of the hills of which it is composed, as they are from ten to thirty feet high; but for their composition and their abrupt, and marked, and distinct outlines. These hills and ridges are short and sharp, and appear to consist very largely of boulders of gray gabbro, the till being gray and stony. On the north side of the former of these moraines, on both sides of the Cloquet river, the surface is smooth, and consists of gravel and sand, clothed with Banks' pine. These flats extend to the Wisacode, but they become swampy. After passing the Wisacode are seen occasional low ridges and knolls with white pine and birch, but cedar and tamarack elsewhere prevail, with extensive peat bogs. At the crossing of the St. Louis there is no deep valley, only a shallow one on drift and boulders, eight or ten feet deep. Timber mainly spruce and tamarack, even on the higher portions. Soil good, loamy, rather darker than the till below, but showing no black loam like that on the prairies. The soil at the moraine a few miles north of the St. Louis crossing, what there is of it, is very good, the subsoil being gray till; but largely made up of boulders. White pine abundant. After passing the sharp ridges of this second moraine the country seems to become converted to a vast "muskeg," or peat bog, with similar low boulder-knolls occasionally seen. These muskegs seem to lie on the summit of the great gabbro range from Duluth, and extend over a width of six to ten miles at least from the moraine mentioned a few miles north of the St. Louis river, to and beyond the Partridge river, which is nothing more than a general ditch in the great muskeg. North from Okwanim, and particularly at a point about eight miles south of the crossing of the Embarras, the surface is gravel-strewn, and smooth to undulating. This gravel consists almost wholly of shingle from the quartzites and slates of the

Animikie group. At the crossing of the Embarras the country is swampy, but has a good soil and is habitable and arable on both sides of the river.

Second—A common feature of the drift, seen in the cuts along the railroad, is represented by the following figure—Fig. 4. The upper portion of the drift, for a thickness of four to six feet, consists of pebbly till, but little stony (1), and the underlying till (2) is very stony, large boulders appearing all over the surface of the cuts. The upper deposit is of nearly the same color as the lower. The till in general, while of a reddish cast, has also a tendency to gray in deep cuts, and to a darker, more umber-like red in the upper deposit.

Fig. 4.



Third—There are two rock ranges, or Mesabis, passed by the railroad between Two Harbors and Vermilion lake, and the name "Mesabi" has been applied to each of them, without distinction. The more southern one is that formed by the gabbro belt running from Duluth northeastwardly to the international boundary, passing south of Gunflint and Mountain lakes, and constituting the actual water-divide between North and South lakes on the international boundary. This includes the high land of the "Mesabi iron ranges," as well as the iron locations at Mayhew lake north of Grand Marais. It is that which which has been most frequently mentioned as "the Mesabi," especially along its eastern extension where it is more distinct and abrupt, particularly from the north, than it is further west. This range of high land always appears *as a range*, from the north, and it operates more powerfully to control the drainage of the northeastern part of the state than the other Mesabi, lying further north. It is,

however, broad as well as high, and holds on its summit some of the largest lakes of this part of the state, Brule lake being one. It is characterized by bare rock, alternating with peat bogs, and muskegs with scattered and stunted spruces. This range should continue to be known as *the Mesabi.* Its width is sometimes fifteen miles, but generally from four to six; and in most places, especially north from Grand Marais, and south from Ogishke Muncie lake, its rounded low crest is distinct, and narrowed to less than a mile. The Duluth & Iron Range railroad crosses this belt of gabbro, as shown by outcrops of the rock, between the St. Louis river crossing and the station of Okwanim. It is also likely that the gabbro rock extends further south, though entirely hid by drift materials.

The other range which has been named *Mesabi* consists of gray granite, or syenite, and it is known also as the *Giant's Range.* It runs along parallel with the former, distant from it from five to fifteen miles. It is a distinct, narrow ridge rising about 200 feet above the average level on either side. It is intersected at several places by streams. It is crossed by the railroad about four miles north of Okwanim, and is less than a mile in width, though granite outcrops (red granite) may be seen at a distance of two miles still further north. This range, with more or less distinctness, continues northeastward to the international boundary which it crosses north of Gunflint lake. It is much less important as a topographic feature, and less persistent in its characters as a range, than the gabbro Mesabi and it should not be confounded with it in future use of the term Mesabi. The survey reports will refer to this as the *Giant's Range*, by which name it is also known in the reports of the Canadian survey, on the north side of the international boundary.

The stratigraphy of the crystalline rocks in the district of northeastern Minnesota, so far as it is indicated by observations of this reconnaissance, is generalized by the following diagram.

Fig. 5.

In passing upward from Two Harbors there are very few exposures, the only ones seen between the station and the crossing of the St. Louis river being within a few miles of the lake shore and consisting of the ordinary greenish "trap" of the Cupriferous. Soon after crossing the St. Louis river there are outcrops of massive, gray gabbro, the same as at Rice's point, near Duluth, and these continue to, and perhaps a little distance north of, the station called Okwanim. Thence northward the surface slopes northward and is strewn with debris of slate, undistinguishable from the slates that have been described along the international boundary, and called Animikie slates; but there is but one place along the railroad at which there is any exposure of rock. This is at the "red pan cut," about two miles north of Okwanim, where a very red and irony outcrop appears extending only about 20 feet. The opportunity for examination was not sufficient to determine the nature of this rock, but the aspect and topography, as well as the geographic position, are sufficient to indicate the horizon of the iron bearing beds of the Mesabi range proper, as described in the report for 1880, or the base of the Animikie group. The gravel which is strewn over the country along here has a considerable quantity of jasper and quartzyte, often nearly black. It continues to the granitic range already referred to as the Giant's range. This rock is massive and rises from 75 to 100 feet higher than the grade. The aneroid showed the station at the summit, as the road passes over the range, to be 155 feet higher than the station at the mines at Tower. The gray syenite composing the Giant's Range is replaced by red at a few cuts by the railroad on the north side of the range, extending for a distance of two miles, at least. For some distance further north, and until after crossing the Embarras river, no rock appears, but at a distance of about 12 miles from the station at the mines at Tower is an exposure of a purplish, aphanitic, hard rock, showing a sedimentary structure that dips toward the north about 75 degrees. The same direction of dip continues at all exposures from there to Vermilion lake, so far as observed. The rock itself is greenish, massive, magnesian, or greenish slaty, and schistose, some of it being like the rock of the ridges between the Northern Pacific Junction and Knife falls. The following diagram is not only based on these observations, but expresses in general the whole that is known of the rocky structure at any point going northward from Lake Superior.

At the mines of the Minnesota Iron Company the rock consists largely of jasper and a magnesian schist, dipping north at an angle of 85°—88°. This magnesian rock is ordinarily green, but in the vicinity of the mines it becomes more and more ferruginous and apparently is changed to iron ore—a soft red hematite. At the same time there are conglomeratic portions, as well as arenaceous. These latter are more abundant on the slope to Vermillion lake, north of the mines. The ore consists, in general, of hematite, but there are also small amounts of non-titaniferous magnetite, and small crystals of gœthite.

Stratigraphic position of the iron ores of northern Minnesota. There seem to be three horizons in the strata that, in northeastern Minnesota, have attracted attention for their iron bearing quality.

First—The titanic iron of the gabbro belt. This includes the iron ore of the Mayhew location north of Grand Marais, the so-called iron ore of Duluth and Herman, and the iron ore that has been reported on Poplar river. This furnishes the iron sand of the lake Superior beach. This horizon of iron ore seems to have no parallels, so far as reported, in Michigan and Wisconsin.

Second—The iron ore of the Mesabi range. This is hard hematite and non-titaniferous magnetite. It is that examined in towns 59.14, and 60.14, and is presumably the cause of the iron ore signs in that tract of country between Okwanim and the Giant's range. It is in the horizon of the Animikie slates, and near the bottom of the same, and the probable parallel of the Commonwealth mines in Wisconsin, without any known equivalants in Michigan.

Third—The hematite of the Vermilion mines at Vermilion lake. This is on the north side of the granite belt, and in rocks dipping north, the other two horizons being on the south side, in rocks dipping south. This iron horizon is lower, in the strata, than either of the others, and seems to be on the horizon of the Marquette and Menominee iron ores, as is also indicated by the associated quartzytes, jaspers, and conglomerates.

III.

THE VERMILION IRON ORES.

The year 1884 having witnessed the opening of the first active mining in the state, its bearing upon the future of this industry, and its importance as a matter of history, both demand of the survey a presentation of the whole matter as full and explicit as the present opportunity may afford. The following facts have been obtained mainly of the officers of the company, and can be accepted as a faithful statement of the present condition and extent of this important new industry.

In every instance where the ore was tried by actual furnace tests, it has proved its superior quality. The company are mining at the rate of 15,000 tons per month, employing at the mines 400 men, but could easily increase their product to 25,000 or 30,000 tons per month.

The buildings, machinery and plant at the mines involved an outlay of fully $300,000, and the ore docks at Two Harbors fully $200,000 more. The whole amount expended, including the building and equipment of the Duluth and Iron Range railroad (sixty-eight miles, from Two Harbors to Tower), by the Minnesota Iron Company in this enterprise is over $2,500,000.

The Vermilion lake iron district, of which the Minnesota Iron Company are proprietors, lies in the south half of township 62 north, in range 15 west, in St. Louis county, Minnesota. The greater portion of the northern half of the township is occupied by lake Vermilion.

The whole of that portion of the township which lies south of lake Vermilion belongs to the Minnesota Iron Company, excepting section 36, which is a school section. This section is in the

southeastern corner of the township, and is not known to contain any iron.

The shipping port on lake Superior for the ores of this district is Two Harbors, formerly known as Agate and Burlington bays (25 miles northeast of Duluth), which affords unusual natural advantages for the erection of ore piers and for safety and convenience of vessels of the largest class. The surveyed line of the Duluth & Iron Range railroad, between the town of Tower, at Vermilion lake, and Two Harbors, is 72 miles in length, with easy grades and curves, and offering no unusual difficulties of construction. The building of this line was done under contract by John S. Wolf & Co., Ottumwa, Ia., well known and energetic railroad builders. The line was ready for the transportation of ore by Aug. 1, 1884. This line will be at once extended to Duluth, and there placed in connection with the railroad system of the United States. The Duluth & Iron Range Railroad company have also built ore piers and made the harbor improvements at Two Harbors under the supervision of Mr. George H. White who built the ore piers at Escanaba. These piers are five feet higher than those at Escanaba and seven feet higher than those at Marquette, thus affording the best possible facilities for loading the largest vessels in the trade.

A general similarity may be observed between the Vermilion lake iron district, in township 62, range 15, and the district in the now celebrated township 47, range 27, in Marquette county, Michigan, which includes the well known Jackson, Cleveland, Lake Superior, New York, and Barnum mines, besides many others of less notoriety.

The Vermilion lake deposits, however, appear to be much larger, as far as first-class ore is concerned, than the mines in township 47, range 27, in Marquette county. The district has been examined by persons who were familiar with all the mines of Marquette county in their earliest stages, among others, Hon. Edward Breitung and Mr. Samuel P. Ely, who are among the pioneers of the Marquette district, and Mr. John N. Armstrong, the veteran Marquette and Menomonee range explorer. In their opinion the quantity of first-class ore now exposed at Vermillion lake exceeds what was exposed of that grade of ore at the same stage of development in all the mines of Marquette county. It is reasonably probable that the mines in township 62, range 15, will, in the natural order of their development, after a reasonable time, yield as much of the highest grade ore

as the mines of township 47, range 27, in Marquette county, with the Humboldt, Champion, Michigamme, and Republic ranges added.

A brief account of the results of the company's explorations thus far will substantiate this statement; although these explorations, by reason of the shortness of the time which has elapsed since the discovery of the deposits and the difficulty of getting in supplies in advance of roads or settlements, have necessarily been partial and imperfect. The most striking and natural exposures only have thus far been named and examined, which will be described in the order of their occurrence, beginning at the most eastern.

The Stuntz mine, in the northeast quarter of the southeast quarter of section 27, township 62, range 15, lies on the north side of a valley between the north and south ranges. By making a rock cutting of about 75 feet, which would be principally through the slates which adjoin the ore on the south side, a face of 75 feet could be obtained for the commencement of mining operations. The surface stripping shows a with of about 25 feet of ore for about 400 feet in length. The stripping westward was stopped by a spring hole and wet ground; there was, however, no reason to suppose that the ore terminated at that point; on the contrary there is a reasonable probability of its continuance westward. The ore is a coarse-grained red specular ore with a good lustre, much resembling the bright Republic ore of Marquette county. The belt is almost entirely pure, needing very little assorting.

The Stone mine, about an eighth of a mile west of the Stuntz, has an elevation of 25 feet above it. At the most eastern end is exposed a narrow belt of slate ore of excellent quality, which appears to be a lens lying in front, or south, of the main deposit. The main deposit is a very large one, of a close grained red specular ore of great purity, much resembling some of the best ores in the lake Superior mine in Marquette county. At the eastern end, so far as now developed, it is about 50 feet in width, gradually increasing, for 300 feet westward, to 62 feet in width and maintaining a width of 46 feet at 700 feet westward.

This body of ore, at its present stage of surface developement, in respect to the combination of size, continuous extent, and great purity, stands without a parallel in the United States up to the present time. Thus far in all the trenches, test-pits, and stripping, there has not been exposed any mixed ore whatever.

	Metallic iron.	Silica.	Phosphorus.
Analysis of surface specimens from this mine made by the Isabella Furnace Co. gave............	68.34	2.14	.053
Another by the Pittsburgh Bessemer Steele Co. gave..	68.19	2.02	.061
Another of numerous small pieces taken from every part of the surface by Mr. S. P. Ely gave.	69.30	......	.059

The Ely mine, west half of the southeast quarter of section 27. This mine includes the extension of the Stone mine westward from the point above described together with a separate deposit lying some 300 feet northwest of the Stone mine. But little surface work has been done at this deposit; although it lies at an elevation of about 20 feet above the Stone mine, the conformation of the adjoining rock occasions more or less wet ground, and it has not yet been convenient to drain the surface, which can be done, however, with little difficulty. This deposit appears to be about 100 feet in width; knobs and projections of pure ore rise above the surface at various points, indicating a large and good deposit. Its dimensions and characteristics cannot be given with the same certainty as in the case of the other mines described, because the surface has not been stripped or trenched for the reasons which have been stated. The ore is of the best quality, however, and the deposit is obviously a large one. From the first of March to the present time more ore has been discovered, both in the Tower and the Stone (in fact in every mine) than was ever known here at the time of the explorations of Chester and Wright.

The Tower mine, east half of the southwest quarter of section 27, is the most elevated deposit on either of the ore ranges. It includes, in fact, two, and perhaps three, distinct mines. The most southern of these deposits is clearly distinct from either of the others; it lies on the line of the Stone and Ely mines, protracted westward, and is probably a continuance of that deposit. The trenches show a width of about 18 feet of clean ore of the best quality. One hundred and fifty feet west of the trench which shows 18 feet of ore is a new discovery which shows clean ore for 150 feet wide. The two more northerly deposits are separated from each other by a jasper "hog's back" about 50 feet in width, and it cannot yet be determined whether they are really separate deposits, or whether they become one again in extension. There are some indications that they become one, and that the Ely mine is an extension eastward of the united deposit.

One of them shows a width of 33 feet and the other of 42 feet of clean ore of the best quality. There has not yet been time and opportunity positively to determine the length of the extension of these bodies westward; but from the lay of the ground there is no doubt of such an extension as will make as large a mine as either of the others.

The Armstrong mine, northwest quarter, section 27. This deposit lies on the northern slope of the Tower range. Two distinct deposits have been discovered here; one of the veins is 15 and the other 30 feet wide, of good ore. Their extent and relation to the other mines of the company have not yet been determined. The deposits of the district are so large and so numerous and have extended over so much territory, that there has not been time thus far to get more than a partial knowledge of them. It is quite possible that the Armstrong may prove to be an extension of the West Breitung, which is described further on.

The Breitung mine, west half southwest quarter, sec. 27, and east half southeast quarter, section 28. The main deposit at this mine furnishes a larger natural exposure of pure ore than either of the others. The natural outcropping before any work was done was about 38 feet in width, 35 in hight, and 75 feet in length, all of the purest ore. Subsequent work shows that at 250 feet east of the outcrop, the deposit is 95 feet wide. Between these points a slide of jasper has covered a portion of the vein for about 30 feet in width for a depth of from three to seven feet; otherwise than this, the ore is continuous to this point, 250 feet eastward. Here the stripping became rather heavy and was discontinued; but at a point 300 feet further eastward, on what is believed to be a continuance of the same deposit, trenches 100 feet apart showed 35 and 38 feet of the same ore with no mixture of rock.

The southern deposit of the Breitung mine lies about 125 feet south of the one just described, upon slightly lower ground. A belt of chloritic schist lies between the two.

This vein has been exposed at four different points; at the most easterly it is 27 feet wide and 100 feet in length, stripped; at the next one it shows about 10 feet in width; at the third, 15 feet, and at the most easterly, 18 feet. The distance between the extreme openings is about 1,000 feet; and there is no doubt that the vein is continuous for that distance. This ore is also of excellent quality.

About 175 feet north of west of the main deposit lies the *West Beitung.* Here has been exposed, for a length of 80 feet, a vein of ore for upwards of 50 feet in width. At that width the stripping became rather heavy and work was stopped for a time, although the limit of the ore had not been reached. This deposit has two jasper walls and is entirely distinct from the other one.

The main deposit of the Breitung mine is a bright, handsome ore, free from any admixture of rock, and can be mined (as can the ore of the Stone mine) of 67 per cent purity without assorting. An analysis made by the Isabella Furnace Company of samples from all parts of a stock pile of 2,500 tons

	Metallic iron.	Silica.	Phosphorus.
gave	68.79	1.34	.038
Another, made by the Pittsburgh Bessemer Steel Co., gave	68.19	1.41	.041
Another, of numerous small pieces taken by Mr. S. P. Ely, from all parts of the deposit, gave	68.51	......	.078

The Lee mine, north half section 33. This is a very large deposit, or rather group of deposits, upon the South range. It includes three distinct ore bodies. The most northerly is nearly or quite 100 feet in width at the point where it was first exposed. The explorations upon this deposit show its continuity, with varying widths, for about 500 feet, and the indications of the formation point to its protraction for nearly 2,000 feet farther westward.

On the highest point of the South Range, about 75 feet south of the deposit just described, a vein some ten feet wide has been uncovered, which rapidly widens as it descends.

A third ore body lies 75 feet farther south and is 36 feet wide This vein extends 700 feet to the eastward, as far as now developed, and is also probably protracted westward, as mentioned just above in respect to the first deposit. The group of deposits which constitute the Lee mine contain extremely large bodies of pure ore; and, so far as any mixed ore is found, it is not, comparatively to the pure ore, in greater quantity nor more difficult of assortment, than in the best of the Marquette county mines. An analysis of the mixed ore from this mine, selected as such by Mr. S. P. Ely, gave 61.59 metallic iron. The following are the analyses of the pure ore from this location :

	Metallic iron.	Silica.	Phosphorus.
Isabella Furnace Co.	66.42	4.67	.031
Pittsburgh Bessemer Steel Co.	66.37	4.72	.039
S. P. Ely's samples, from all parts of the mine...	67.80	......	.053

The Minnesota Iron Company intend to place a sufficient quantity of their ore in market at lower lake ports in the autumn of 1884 to make it known to consumers, and thereafter to produce as much as the market may require of the highest grade of ore, up to an amount equal to, or greater than, the Marquette county product of that kind of ore. As a matter of course, an unlimited amount of ore cannot be produced in a single year, and some years of development and organization of the business must pass before the full productive capacity of these mines can be reached. It will be observed that all the Vermilion lake ore is sufficiently low in phosphorus for Bessemer use, and that a practically unlimited supply of such ore can be obtained, which is also of the highest standard in metallic iron.

The existence of such ore bodies is a fact of almost national importance, and their speedy exploitation is of the greatest interest to the whole iron-producing industry west of the Alleghanies.

The policy of the Minnesota Iron Company will be to ship only the best ores. Such mixed ores or soft hematites as may be developed in the course of its mining, will be for sale at the mine for those who may require them; but the company's own product and shipments will be confined to the ores of the highest grade. Lake transportation will not be materially higher than that from Marquette to lower lake ports, by reason of the large and increasing quantity of coal which is seeking transportation to the head of lake Superior, which will give a remunerative up freight to the ore vessels.

The rapid growth and development of several of the mines in Michigan is exhibited by the following table, showing the product of the five largest mines of Marquette county, Michigan, during the last ten years.

PRODUCT OF FIVE MINES OF MARQUETTE COUNTY, MICH., FOR TEN YEARS, ENDING IN 1882,

IN GROSS TONS.

	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	Total for ten years.
Jackson mine	130,131	105,600	90,568	98,480	80,340	83,121	103,219	120,620	118,939	96,830	1,027,848
Cleveland mine	133,265	105,858	129,881	146,393	152,188	152,737	131,167	212,748	198,569	206,120	1,568,926
Lake Superior mine	158,078	114,074	129,339	111,766	127,349	109,674	173,938	204,094	262,235	296,509	1,687,056
Champion mine	72,782	47,097	56,877	66,002	70,883	73,464	94,027	112,401	145,427	159,009	897,969
Republic mine	105,453	122,639	119,726	120,095	165,839	176,221	135,231	235,387	233,786	235,109	1,649,486
	599,709	495,268	526,391	542,736	596,599	595,217	637,582	885,250	958,956	993,577	6,831,285

The probable productive duration of iron ore deposits of this character is a question in respect to which some valuable experience has been gained in working the Marquette deposits. The following table shows the aggregate production of the five Marquette county mines which have been before cited, from their first opening to the present time:

	Total production in gross tons.
Jackson mine	2,291,992
Cleveland mine	2,535,184
Lake Superior mine	2,962,965
Champion mine	1,134,912
Republic mine	1,660,508
	10,585,561

The Jackson, Cleveland, and lake Superior mines have been worked continuously since 1858, the Champion mine since 1868, and the Republic mine since 1872. Notwithstanding their large product, all of them excepting the Jackson, have as much, or more, ore in sight and as great a future product in prospect, as at any time in their history.

TABLE OF ANALYSES OF HARD HEMATITE IRON ORES

FROM THE

MINNESOTA IRON COMPANY'S MINES

IN THE VERMILION IRON DISTRICT,

VICINITY OF TOWER, ST. LOUIS COUNTY, MINN.

AUTHORITY.	Metallic Iron.	Silica.	Sulphur.	Phosphorus.
J. Blodgett Britton, Philadelphia, March, 1880, select samples	69.69	......	......	.019
Prof. Albert H. Chester, Clinton, N. Y., October, 1880, samples taken by himself from all parts of north belt	66.93	3.39	.01	.011
Samples taken by himself from all parts of south belt	66.43	3.89	none	.006
North Chicago Rolling Mill, Nov. 18, 1880, duplicates of Prof. Chester's selection, north belt	65.22	3.45	none	.064
North Chicago Rolling Mill, south belt	66.18	3.75	none	.039
Chas. E. Wright, Marquette, Mich., Sept. 1, 1881, samples taken by himself from every part of north belt	66.71	2.40	.018	.072
Do. Do. south belt	67.60	1.35	.009	.027
Isabella Furnace, Etna, Allegheny Co., Pa., Oct. 20, 1882, samples from all parts of a stock pile of 2,500 tons at the "Breitung" mine, north belt	68.79	1.34	......	.038
Isabella Furnace, samples from the "Stone" mine, north belt	68.34	2.14	......	.053
Isabella Furnace, surface samples from the "Lee" mine, south belt	66.42	4.67	......	.031
Pittsburgh Bessemer Steel Co., Nov. 10, 1882, samples from all parts of a stock pile of 2,500 tons at the "Breitung" mine	68.51	1.41	......	.041
Pittsburgh Bessemer Steel Co., surface samples from "Stone" mine	68.19	2.02	......	.061
Pittsburgh Bessemer Steel Co., surface samples from "Lee" mine	66.37	4.72	......	.039
J. Blodgett Britton, Philadelphia, Dec. 20, 1882, sample of slate ore from the "Stone" mine	69.93	.73	......	.033
Average samples taken from all parts of the "Lee" mine, by S. P. Ely, January, 1883, analyzed by Chas. E. Wright	67.80	......	......	.05[illegible]

Average samples taken from all parts of the "Stone" mine, by S. P. Ely, January, 1883, analyzed by Chas. E. Wright.........	69.30	......	......	.059
Average samples taken from all parts of the "Breitung" mine, by S. P. Ely, January, 1883, analyzed by Chas. E. Wright..	68.51	......	......	.078

The foregoing are all hard hematite specular ores, and are all the analyses that have been made of the ores of the district above named since the Minnesota Iron Company commenced its exploration in 1879, excepting a single one of mixed ore from the "Lee" mine, selected as such by Mr. S. P. Ely, which has been mentioned in the foregoing pages.

Besides the land in township 62, range 15, which has been mentioned, the Minnesota Iron Company own several thousand acres in the adjoining township on the east, township 62, range 14, selected to cover any extension eastward of the Vermilion lake range, and also several thousand acres along the line of the Duluth & Iron Range railroad, and 3,000 acres at Two Harbors on lake Superior; making in all 22,488 acres.

Shipments in 1884. During the short season of 1884, after the completion of the Duluth and Iron Range railroad, and the construction of the necessary docks at Two Harbors, the products of the Vermilion mines amounted to about 1,000 tons per day, the aggregate product being 62,000 tons, distributed to various furnaces and iron works in Ohio, Pennsylvania, and Virginia.

RECENT ANALYSES OF THE VERMILION IRON ORES.

St. Paul, Minn., March 6th, 1885.

Prof. N. H. Winchell,
State geologist, Minneapolis, Minn.,

Dear sir: As I promised you, I give you below eight late analyses of our ore:

Metallic iron.	Phosphorus.	Silica.	Metallic iron.	Phosphorus.	Silica.
66.70	.042	3.71	69.27	.044	.084
68.37	.060	1.56	67.75	.051	2.07
65.65	.036	5.48	67.84	.061	1.77
66.94	.031	3.65	67.02	.051	1.75

Yours Truly,
George C. Stone, Gen'l manager.

IV.

THE CRYSTALLINE ROCKS OF MINNESOTA.

There is a series of gneisses and soft red granites, or more properly, syenites, associated with the gabbro belt in the northeastern part of the state. This red granite, or "red rock," as it has been styled in earlier reports, is believed to be due to metamorphism of sediments that had been deposited at a date but slightly prior to the outflow of the gabbro itself; and, as it has been seen to pass into subcrystalline rock and quartz porphyry, and, as similar or identical quartz-porphyry and felsite are formed when in immediate association with masses of red granite and of gabbro, interstratified with the igneous outflows of the cupriferous, this red granite has hitherto been believed to belong in the age of the cupriferous, and for the same reason the gabbro has been accepted as the basal igneous rock of the cupriferous. The cupriferous overlies the Animikie slates and quartzites; and the great igneous capping of the Animikie hills along the international boundary, from Gunflint lake to Pigeon point, is in the direct line of extension of the gabbro range. This belt of syenites and granites, with the gabbro, disappears at the west end of lake Superior, beneath the waters of the lake and of the St. Louis valley. Further southwest, and in the line of their extension, however, are outcrops of red and gray granite, on the Rum river, south of Mille Lacs, on the Mississippi river between Clearwater and Watab, and on the Minnesota river between New Ulm and the foot of Big Stone lake. The granite rocks that appear in the Mississippi valley are not lithologically similar to those of this series, while those of the Minnesota valley are more nearly identical with them. There is an outcrop of the basal igneous rocks of the Cupriferous at Taylors Falls, overlain uncomformably by some of the Cambrian (probably the Calciferous

period), indicating that the strike of these granite rocks is further south than the outcrops on the Rum and Minnesota rivers.

Still, whether these upper Mississippi granites be the analogues of the red granites north of Lake Superior, or not, those that appear at New Ulm, as they underlie a conglomerate and red quartzite, have a greater degree of probability of being on the same horizon, and exhibit also a greater lithological resemblance. In any case the gabbro is entirely lost sight of. As an outcropping, overflowing rock, the gabbro may be considered, perhaps, to have had a more intense effect as a metamorphosing agent, but one less extensive geographically, than was the effect of those forces which made possible and necessary that outflow, when acting over a broader area without actual fracturing of the crust. Thus, perhaps, the metamorphism of the strata immediately preceding the age of the gabbro outflow, may have been more profound toward the southwest further, where no gabbro is found. In apparent consonance with this, the crystalline rocks, which might be in the extension of those slates and quartzites underlying the gabbro, are found to occupy a wider belt where they cross the Minnesota valley than where they are associated with the outflow of igneous rock in northeastern Minnesota. Their prevailing schistose structure, dipping toward the southeast, if it be due to original sedimentation, is in harmony with the known strike of the red syenites northeast from Duluth. This dip seems to be changed to northwest at the foot of Big Stone lake, indicating that the Minnesota valley passes over an anticlinal in these rocks, extending from Big Stone lake to the red granite outcrop near New Ulm.

Lying toward the north of the belt of red granites of northeastern Minnesota, is a series of schists and slates, containing the iron ores of the Mesabi, and of Vermilion lake. The subdivisions of this series, so far as they can be indicated at this time, are three, viz.: (1). Slates and quartzites, with beds of dioryte (Animikie group), which, in their extension toward the southwest, would, under the foregoing hypothesis, embrace the dioryte-bearing mica schists at Little Falls, Pike Rapids, and Sauk Centre, as well as the dark carbonaceous slates of the St. Louis valley at Knife portage; and finally become the schistose granites of the Minnesota valley anticlinal. (2). Soft, greenish, slaty schists, which hold lenticular masses of light-colored pro togine gneiss, and also beds of dioryte. The horizon of the Vermilion iron mines is thought to be near the bottom of this sub-

division, or at the top of the next, but on the opposite side of a Laurentian axis, dipping north, and that of the Mesabi iron range, in the foregoing subdivision, dipping south. (3). Conglomeritic and quartzitic slates, which become fine, arenaceous quartzites, and also embrace beds of siliceous marble.

Still further north, and having a strike in the same N. E. to S. W. direction, is another range of crystalline rocks, forming a conspicuous feature both in the topography and in the geology of that part of the state. The rocks of this horizon, accepted now as the Laurentian of the Canadian geologists, consist of gneiss and syenite, mainly of a light, gray color, but also becoming red. The "Giant's range" of hills is formed by this rock. They enter the state at Saganaga lake, north of Gunflint lake, and with more or less distinctness continue southwestward crossing the Duluth and Iron Range railroad at "Messaba Heights," and the Embarras river at Squagamaw lakes. Toward the west further this range has not been traced out by the survey, but, judging from all the facts and evidences that can be gathered from other sources, this belt of Laurentian turns more westerly, passing through the north central part of the state, and swings northwesterly along the west side of the Lake of the Woods, reappearing on the east side of lake Winnipeg.

On the north side of this Laurentian axis are other crystalline rocks, occupying nearly all the remaining area of the state, outcropping along the Rainy lake river, in the Lake of the Woods, and east of Rainy lake. These seem to be alternating bands of schists and gneiss, and their extent and nature have not been ascertained.

V.

ADDITIONAL ROCK-SAMPLES NUMBERED.

The last recorded number of this series is given in the Tenth Annual Report, page 122.

No. 837. Fragments from 195 feet under Minneapolis; red quartzyte, from the deep well at the Washburn "C." mill.

No. 838. Brick-red quartzyte, from Redstone, near New Ulm.

No. 839. Fine-grained gray syenite from Sauk Rapids, Museum Register No. 4466.

No. 840. Fine-grained gray syenite, like the last from East St. Cloud, Museum Register No. 2128.

No. 841. Granite from near (north of) Motley, Museum Register No. 2596.

No. 842. Greenish syenite (1) from secs. 17 and 18, Ashley. Museum Register No. 4499.

No. 843. Dyke in the Motley syenite. Museum Register No. 2593.

No. 844. Dyke in the Motley syenite, very fine-grained. Museum Register No. 2595.

No. 845. Dyke in the granite at Sauk Rapids. Museum Register No. 2122.

No. 846. Amygdaloidal dyke rock, Maine Prairie. Museum Register No. 2123.

No. 847. Slate, fine-grained, showing sedimentary structure and slaty cleavage running in different directions, crossing each other. Museum Register No. 2681.

No. 848. Fine gray quartzyte, at least a fragmental rock though containing other minerals besides quartz, glistening with fine sparkles on a freshly fractured surface, from Little Falls. Museum Register No. 2690.

No. 849. Staurolite mica schist, Pike Rapids, near the mouth of Swan river. Museum Register No. 2689.

No. 850. Fine crypto-crystalline form of the red-rock, at Duluth, of a reddish brown color; the same as No. 42, but fresher, and less granular.

No. 851. Red granite, from Courtland, Nicollet County, opposite New Ulm.

No. 852. Conglomerate (Potsdam) Courtland, Nicollet County, opposite New Ulm.

No. 852. A. B. C. D. E. F. Pebbles from 852.

No. 853. Pyritiferous red granite, from Mannheim's silver mine, Duluth.

No. 853 A. Vein rock from Mannheim's silver mine, Duluth.

No. 853 B. Vein rock (calcite) from Mannheim's silver mine, Duluth.

No. 854. Traprock from Taylor's Falls, containing metallic copper in minute particles.

No. 855. Dark concretions from the slates at Thomson, thought by Hunt & Dawson to contain a keratose sponge.

No. 856. Vein in gabbro, at Rice's point.

No. 857. Conglomerate of shale in white sand-rock, Fond du Lac.

No. 858. Average samples of the red syenite (micaceous) at Sauk Centre, quarry of T. Carl.

No. 859. Average sample of the hard, dark schist, or gneiss, Sauk Centre, quarry of T. Carl.

No. 860. Sample of the schist showing considerable mica, Sauk Centre.

No. 861. Average sample of the massive dioryte, Sauk Centre. This is the same as described by Streng in the eleventh annual report, page 72, and by Upham on page 103.

These rocks from Sauk Centre are described on page 12.

No. 862. Pinkish, white quartzyte, Garden Valley, seven miles from Merrillan, Jackson County, Wis.; probably shows Irving's "deposited quartz." It is also probably from this that Whitfield's *Palæacmæa Irvingi* was obtained. See Vol. IV, p. 173, *Geology of Wisconsin.*

No. 863. St. Peter sandstone, from the small island in the Minnesota bottom-lands near Fort Snelling, cemented with iron and ("deposited"?) silica, so as to be hard and show different colors.

VI.

THE HUMBOLT SALT WELL IN KITTSON COUNTY.*

It has been known for many years that copious salt springs existed in the valley of the Red river of the North. From their abundance several streams have been named, as Salt river, and "Rivierè Salé." Some of these springs are in Dakota, some in Minnesota, and others, probably the most numerous and copious, are in Manitoba. Some of the earliest French explorers, notably Sieur Du Luth, mentions the fact that the Indians exhibited salt which they said had been obtained in the vicinity of certain lakes in the western prairies, said to be fifteen or twenty days travel further west.

Prof. Henry Youle Hind, in his report on the Assiniboine and Saskatchewan exploring expedition, in 1859, has summarized the principal facts respecting these springs and the salt deposits of the valley of the Red river of the North. They had been made known in Dakota and Minnesota by Prof. Keating in 1823, who accompanied Major Long to the "Sources of the St. Peter's river and lake Winnipeg." At that early date five hundred dollars had been made by a single individual from the sale of salt manufactured in one summer near Pembina. The country was so permanently and extensively saline that the characteristic *Salicornia herbacea* was found growing abundantly in its natural wild state, the only inland locality known west of the Onandaga salt springs, in New York. In 1859 the manufacture of salt from springs in Manitoba was carried on profitably for the Hudson's bay company, at Swan river and at Winnipegosis lake, the methods of manufacture being of the rudest kind.

South of the international boundary several deep wells have

* Read at the Philadelphia meeting (1884) of the American Association for the Advancement of Science.

been sunk within a few years for the purpose of getting a supply of water for stock and farming purposes. Some of these have given an artesian overflow of brine. The first of this kind in Minnesota was sunk at St. Vincent, which is on the Red river of the North at the crossing of the international boundary. This well was 165 feet deep, and only penetrated the drift deposits, the greatest thickness being taken up with a fine lacustrine clay, 112 feet in perpendicular thickness. Under this was found to be coarse gravel and sand which afforded a copious overflow of salt water. This water was not carefully analyzed, though Dr. Perley, at Fort Pembina, made tests sufficient to show it was a brine principally of chloride of sodium, but contained a considerable quantity of magnesium and calcium.

Recently another well has been sunk on the Valentine farm, at Humboldt, about six miles southeast from St. Vincent, on the line of the St. Paul, Minneapolis & Manitoba railway. This also gives a strong salt water, which rises under natural hydrostatic pressure several feet above the ground. The water is clear, and effervesces slightly on exposure to the air and the removal of the pressure.

The section penetrated by this well was the same as that at St. Vincent, but extends much deeper. The salt water was found to rise first from a bed of gravel and sand at a depth of 165 feet, but in small quantity. Between 170 feet and 180 feet, the flow of brine became very copious, rising from a coarse gravel and sand pertaining to the drift. The object of the well being to obtain water for the use of the farm, the drill was sunk deeper. It at once entered a dolomitic limestone, which was found to be 295 feet thick. This has a grain and color like that which is known as the St. Lawrence limestone in the Mississippi river bluffs. Beneath this was found a saccharoidal, siliceous sandstone of rounded grains of quartz, that still furnished a flow of salt water, which rose with still greater force. The drill then entered greenish and reddish shales, some of these being of a reddish-umber color. Fragments from the pumpings show this shale is slightly unctuous, gritless, and compactly impervious, resembling the red shale which has been penetrated in a number of deep wells in the state, and been found to have a great thickness; notably the well at Mankato in the Minnesota valley. While this shale, as shale, is impervious, it is interbedded with red sandstone, particularly in its upper portion, and from these beds of sandstone may rise an artesian flow of fresh water. At the time of my visit it had been entered but forty-six feet.

Mr. C. F. Sidener, of the university of Minnesota, analyzed this brine, and has reported the following composition of the soluble mineral ingredients:

	Grains per gal.
Silica	12.15
Aluminum oxide	2.38
Carbonate of iron	1.08
Calcium sulphate	116.08
Calcium chloride	156.55
Magnesium Sulphate	71.12
Magnesium carbonate	78.60
Magnesium chloride	91.44
Potassium chloride	42.26
Sodium chloride	2764.99
Total mineral ingredients	3336.65

Of the mineral ingredients this gives 82.8 per cent chloride of sodium, the rest being largely made up of the earthy chlorides of calcium and magnesium, and the sulphate of lime. This gives it more than the average per cent of chloride of sodium found in the Michigan brines, while the total solid matter in solution is only from one-third to one-half as much.

There is an interesting question presented by these salt springs and deep wells, of the Red river valley, viz.: From what formation does the brine issue primarily? Professor Hind inferred, from the great predominance of the salt springs over the rocks of the Devonian age, along the southwesterly side of lakes Winnipegosis and Manitoba, that the brine issues from the rocks of the Devonian. He rather discourages the expectation of carboniferous strata in the region explored by him, saying that "it appears tolerably certain that the carboniferous series is not represented in the only locality where it may be looked for with much chance of success." Sir Roderick Murchison, however, in his address before the Royal Geographical Society, on the results of the "Palliser expedition," distinctly states that it is definitely settled that in the western portion of the Saskatchewan valley the Devonian rocks are overlain by carboniferous strata. It seems reasonable to infer that these carboniferous strata extend far enough southeasterly to occupy the unobserved interval of four hundred feet of strata, stretched over a space of ten miles in breadth, "between the salt springs south of Dauphin lake, and the outcrop of the cretaceous shales on the flanks of Riding moun-

tain."* The gypseous and salt-bearing formation of Michigan might occupy this interval. That the salt water issues from near the summit of the Devonian, if from the Devonian at all, is admitted by Professor Hind. In order to issue thus along the summit of the Devonian outcrop, it must be confined in some superior basin. Professor Hind also brought home a specimen of *productus*, which had been given him by a half-breed, who had extracted it from "solid rock;" but he is disposed to discredit the authenticity of this reported "solid rock," and to refer the fossil to some boulder transported from the south by floods and ice in the Red river, although Mr. Billings, who examined it, says that "there seems to be evidence of the existence of at least a portion of the Carboniferous system in this region." The salt-bearing beds of the Carboniferous in the state of Michigan have since been brought to light, and they yield that state a very important source of wealth. Had this fact been known by Professor Hind, it seems to me he would not so summarily have dismissed the idea of Carboniferous salt-bearing strata, and all other Carboniferous strata so plainly indicated by the single specimen of *productus*.

The horizon from which the brine issues at Humboldt appears to be in the Cambrian. It seems to pervade several geological horizons, from the summit of the Devonian downward to the Potsdam — but only superficially, the original source being higher than the Devonian. It is confined by the overlying sheet of impervious clay of which the drift mainly consists in the Red River Valley, and is held under hydrostatic pressure by the downward pressing fresh waters that enter the same pervious-gravel-and-sand stratum at higher levels toward the east, south and west. Where the salt springs occur it finds escape to the surface through openings in the clay-sheet. These springs seem to be most frequent and copious in Manitoba, along a belt of country running east and west, where, for some reason, the drift-sheet is much less thick than it is further south. That brine so pure and so strong should be found at so great a distance, both stratigraphically and geographically from its source, indicates the purity and strength of the brine in its native strata.

It remains for the future to determine whether these salt deposits shall become economically of importance to the Northwest. It is certainly the dictate of wisdom to give them a thor-

*Reports of Progress, together with a preliminary and general report on the Assiniboine and Saskatchewan Exploring Expedition. Original edition, quarto, p. 175. Henry Youle Hind.

ough examination and a fair trial. If these brines originate in Carboniferous strata that strike through the base of Riding Mountain, they can easily be discovered in their native place. If those strata exist in that locality the strongest brine would naturally be found by sinking wells into them at some point further toward the south and southwest.

A sample of salt made from this well was exhibited at the New Orleans Industrial and Cotton Centennial Exposition, this being the first ever made from brine native to the state of Minnesota. It was furnished by Mr. Valentine.

Section of the Humbolt Salt Well.

This well is on the line of the St. Paul, Minneapolis & Manitoba railroad, near St. Vincent, in Kittson county, S. ½ of sec. 23, T. 163, 50, five miles east of the Red river of the North, and four and a half miles south of the international boundary. It is seven feet above the highest known flood stage of the river, *i. e.* for ten years.

1. Soil (8–12 inches black).. 4 feet.
2. Lacustrine clay, with lime concretions, appertaining to lake Agassiz. In this is found good surface water, and many wells stop in it. It is somewhat pervious to water, so much so that it sometimes allows free entrance of good water. It is very fine and can hardly be called sand, though it is probably the same as called sand at the Lockhart farm........................ 4–16 feet.
3. The same deposit as the last, but more impervious, hence more moist, darker colored, gritless, and thought to be (wrongly) the cause of foul water. This is very slippery, rather darker than can be called "blue clay," yet is apparently a downward continuation of the last.. 16–140 feet.
4. Pebbly blue till; salt water at 165 feet in small quantity.. 140–160 feet.
5. Drift gravel and sand, supplying an abundant discharge of salt water, flowing over the surface. This is mainly a gray sand, but contains drift pebbles as large as an inch, mainly of limestone.. 170–180 feet.
6. Dolomitic limestone, of a grain and texture like the lower magnesian of southeastern Minnesota, in fragments obtained by driving a pipe into the drilled hole; of a buff color........... 180–190 feet.
7. Powder, of the color of the last; effervesces in NO_5; supposed to be the drillings obtained from the same rock at greater depth; very fine and unidentifiable by the naked eye............... 190–300 feet.

8. Powder, effervescing rapidly, containing some fine fragments of a compact fine-grained limerock of a slightly reddish cast	300–400 feet.
9. Fine drillings of a reddish limerock of shale, with some grains of white quartz. When washed the grains are seen to be mainly of limestone	400–475 feet.
10. Reddish sand, of rounded quartz grains. The flow of salt water increased	475–500 feet.
11. White sand, of rounded quartz grains. Flow of water still further increased	500–532 feet.
12. Faintly reddish quartz sand, in rounded grains	532–546 feet.
13. "Soapstone" shale, slippery, red and green, apparently in some alternation, the only representatives of this being in masses of powdered rock and fragments that adhered to the sides of the drill. When washed the grains consist of reddish and gray, or grayish-green shale with considerable white sand	546–550 feet.
14. The same in condition of wet paste, having a dark gray color	550–556 feet.
15. The same, reddish-brown, or umber-brown	556–560 feet.
16. The same, brown, but containing grains of a white mineral which in the air turns to a white powder. It effervesces in nitric acid	560–571 feet.
17. The same, but having a more liberal intermixture of a green color, so as to be in general considerably lighter. When washed this shows many bits of dark green shale, and also some of brown, as well as white sand	571–592 feet.
18. Greenish-gray shale, the same as No. 13	592–610 feet.
19. Greenish shale, containing bits of grayish quartzyte that feebly effervesce in hydrochloric acid. This is unwashed	610–635 feet.
20. The same unwashed	635–638 feet.
21. Washed grains consisting mainly of rounded quartz (from above), angular, opaque, gray quartz, freshly fractured, and numerous scales and masses of mica. It appears as if the rock here struck is a greenish-gray, foliated, micaceous quartz-schist	638–639 feet.
22. Washed drillings, consisting mainly of bits of angular quartz (some, however, are rounded, probably from above), black mica scales, and angular grains of flesh-colored orthoclase, and a white feldspar, evidently one of the Laurentian granites as seen at the Lake of the Woods	639–641 feet.
23. The same, but cut much finer, and showing rarely a greenish scale as if of talc	641–644 feet.

The boring ceased at 644 feet.

Other deep wells in the valley of the Red river of the North.

Further information respecting artesian and other deep wells in the northwestern part of the state, and particularly in the valley of the Red river of the North, is contained in the sixth

annual report, in the eighth annual report (page 113), in the ninth annual report (page 166), in the eleventh annual report (page 146), and in the following letter from Mr. Springer Harbaugh:

ST. PAUL, MINN., March 20, 1885.

Prof. N. H. Winchell, State Geologist of Minnesota:

DEAR SIR: You have asked me to give my experience regarding artesian wells in the Red River valley, as well as other matters that have come under my observation in this comparatively new and undeveloped country. I will gladly comply with your request, and if I can impart any information that will be of interest to your constituency, or the country generally, I will be indeed gratified in so doing. We commenced our first farming operations on the Keystone farms, located in Polk county, Minn., and on the Lockhart farms, located in Norman county, Minn., in the spring of 1880. The first matter that demanded our attention was to find water for the large amount of stock required in our operations. We sunk and curbed at both places several wells to the depth of from forty to sixty feet, and found an inexhaustible supply of water in all of them. In some of the wells the water came up to within a few feet of the top, and at first it was sweet and good, but after a few days' standing it became so obnoxious that it was not fit for man or beast to drink. We then conceived the idea of drilling down a greater distance and casing with six-inch pipe. Our first effort was made at the Lockhart farms, in 1880. After reaching a depth of about one hundred and sixty feet we struck an extraordinarily heavy flow of water, apparently sufficient to propel a mill with one set of burrs. At a distance it had the appearance of a monument thirty or forty feet high. During the winter of 1880–81 the pipe of this well became filled up with gravel and sand and stopped flowing. We endeavored to clean it out in the spring of 1881, but the well driller lost his drill in the pipe and it became so imbedded in the sand and gravel near the bottom that he was unable to extract it with his inadequate appliances, and we drilled another well a short distance from the first and struck water at about the same distance down, of large flow, but not so heavy as our first well, and which still keeps up a regular and undiminished supply, which we have carried into our buildings

through pipes, and thus we have a great abundance of water of the purest character for all domestic purposes. Fearing that we might again have trouble and possibly the pipe again become obstructed, we subsequently drilled another well at our Lockhart farm headquarters about seven hundred feet distant from our first well, and struck water at about the depth of one hundred and thirty-seven feet, and the flow and pressure was alarmingly heavy. Within twenty-four hours the water found vent alongside the pipe, making a large hole and fairly boiling up in such large and alarming quantities that we soon became inundated, and we at once concentrated a large force of ditchers from St. Paul and the neighboring towns, and constructed ditches several miles to the west, to carry off the surplus water. After, say a couple of weeks, this heavy flow somewhat ceased, and has since been principally confined to the pipe with only a moderate and controllable quantity coming to the surface outside the pipe. This flow through the pipe is still heavy and strong, and could be carried through hose to the highest points of most any building. We sunk other wells on this farm, and cased with three-inch pipe, and have quite heavy flows of pure, semi-soft water. At the Keystone farms, in town 152, range 48, during and since 1881 we have drilled eight artesian wells, and they all have regular, continuous flows of pure, good, semi-soft water. With our first wells we used six-inch pipe, then three-inch pipe, and subsequently two-inch, which we regard sufficiently heavy for farm use. We struck water on this farm at from ninety-five to one hundred and twenty feet, with one exception, where we reached water at one hundred and fifty feet. At one point of this farm where the land is elevated about five feet above the surrounding country, we drilled several test wells and found brackish artesian water at the depth of ninety feet, which we abandoned. We then determined to drill considerably deeper, and struck a pretty heavy artesian flow of milky, brackish tasting water, at the depth of two hundred and fifty feet, which we immediately abandoned, and then selected a point on lower ground, 1,200 feet distant, and found good artesian water at about the depth of one hundred feet. We have now eleven good and satisfactory artesian wells on both farms. In drilling these wells we penetrated through strata of earth about as follows: First through the usual black loam from one and a half to three feet in depth; then through a lightish clay marl from five to seven feet in depth; then through a blue clay varying from thirty to sixty feet in

depth; then a stratum of hard pan; then sand, and finally gravel, when water is generally struck. Between these strata we generally passed through intermediate seams of quicksand and also seams of gravel. I will at this point state that the light clay marl, as well as the blue clay, appears to be fully impregnated and mixed with all the chemical and fertilizing elements requisite to produce the peculiar kind and quality of grain that is becoming so valuable and necessary for human food. I claim that our subsoils are strong and valuable fertilizers. The blue clay when first brought up is pliable, greasy, and of a puttyish nature, and when exposed to the air and dried it makes a valuable dressing for the land. It is, therefore, fair to suppose that we have our fertilizing elements immediately under us for all time to come, and which gives inestimable value to the lands of the Red River Valley and our Northwestern country. I am advised that the farmers of Clay, Norman, and Polk counties are sinking a great many wells, and have generally been successful in obtaining good artesian flows of pure water.

Before closing this communication I beg leave to call your attention to the matter of natural gas, which, as you are aware, is attracting the attention of the people of Western Pennsylvania, West Virginia, and Northeastern Ohio, and working such a marvelous revolution in utilizing it for fuel and heating purposes in those sections of our country, and to such an extent that it is largely taking the place of coal in the various large manufacturing establishments and in private families, at a comparatively small cost as compared with even the present cheap fuel of those sections. This natural-gas is obtained in drilling to the depth of from 1,500 to 2,000 feet, and is frequently conveyed in pipes very many miles; the pressure varies, but it is extremely heavy. I merely advert to this matter to give you scientists and thinkers a little food for reflection. Is there any probability of our finding natural gas and reaching it at any practicable working depth in this northwestern country? I am impressed with the belief that our good Creator has something in reserve for us, and that this great and good country will not have to be dependent for ages upon distant localities for this all important element to the comfort of mankind. Whilst it may be scientifically thought that Minnesota is located outside the belt where natural gas can be reached, I am still deeply impressed with the belief that efforts should be made whereby the question can be practically tested, and at least use the means to the end hoped for. Very respectfully,

SPRINGER HARBAUGH.

VII.

THE DEEP WELL AT LAKEWOOD CEMETERY, MINNEAPOLIS.

This well is situated on the south side of the cemetery, near the beginning of the tamarack swamp, which connects lakes Calhoun and Harriet, but on high ground, about 50 feet above the lake. It is 75 feet above the Milwaukee depot, or about 900 feet above the sea.

The following general statement of the drift was obtained from the Superintendent (F. M. Gray) and from observations on the drillings as they were shown during the progress of the work. Samples of these, and of the rock strata, to the bottom of the well have been preserved and are deposited in the General Museum for future reference and verification:

1. Gravel and sand; mainly referable to the blue till as its source. It is suitable for road-making; the upper portion of this, not noticed by Mr. Gray, consists of yellow loam, such as covers the most of the country, making the soil, having a thickness of 1-4 feet........ 135 feet.

2. Yellowish, ochery, or rusted clay in which the stones, and all boulders, one of which was broken and brought up in fragments, have a ferruginous coating or weathering.............. 135–138 feet

[This seems to have been the bottom of the old preglacial (rather interglacial) river gorge. It is evinced by this weathered material. A boulder of syenitic gneiss as large as a man's fist, which was said to have been brought up in the pump, was exhibited by the men at work. It was weathered and looked so much like a surface pebble, such as can be found anywhere now on the top of the ground, that at first this statement was disbelieved. But when the Superintendent showed a piece of hard gray granite, evidently freshly fractured by the drill, having a red weathered exterior, I was inclined to believe that the pebble of gneiss also may have come from this depth.]

3. Blue till............ 138–212 feet.

4. Gravel and sand and blue till. This was changeable, and seemed to be as if interstratified, but of course that could not be stated on the basis simply of the pumpings........................... 212–248 feet.

5. Boulders of Trenton limestone, and of granite, with some sand all more or less involved with some blue till. The rock was struck next below this, and at a depth of 264 feet beneath the surface. This depth seems to demonstrate the existence of some great excavation in the strata, probably, as supposed in the report on Hennepin County,* the old gorge of the Mississippi river, at least in interglacial times....................................... 248–256 feet.

6. Quartzose sandstone, in friable strata or massive, composed of rounded grains of pure quartz................................. 256–276 feet.

7. The same .... 276–296 feet.

8. The same.. 296–318 feet.

9. At the depth of 318 feet about one-half of the washed drillings are found to consist of dolomitic rock, and the rest of the same white sand. Some of the coarser fragments show that this dolomite is compact, fine grained, of a yellowish-gray color, approaching, in both respects, some of the strata of the Cambrian. Occasional fragments of crystalline rock, found in the drillings here, and before, evidently are derived from the drift below the point at which the pipe stands on the boulders, etc., of No. 5 ... . 318 – 320 feet.

10. At 325 feet the pumpings consist almost entirely again of white sand. Hence the dolomitic layers seem to have been not greater than ten feet in thickness.................................. 320 – 325 feet.

[At this point some pebble or other obstruction in the drill-hole caught the drill and caused the breaking of one of the wooden poles, and a delay, the drill being lodged and wedged fast. When the drill was got started again and the pumpings were preserved, the samples exhibited (Aug. 15) were said to have come from the depth of 360 – 403 feet, and nothing was said of the interval between the last preserved record (325 feet) and 360 feet. Hence there is no certainty whether it contained drillings like those at 325 feet or at 360 feet.]

11. Slightly red, fine grained, dolomitic rock, of homogeneous characters.. 360 – 403 feet.

12. About one-half of the drillings are like the last, and the rest are of rounded, white, translucent, quartz-grains like the next. It is probable that the mixture is occasioned by the infrequency of the pumping, and not by an original mixture in the rock. The transition from dolomite to sandrock took place in this interval.. 403 – 416 feet.

13. Translucent, rounded grains of quartz, almost nothing else .... 416 – 424 feet.

14. The same as the last. At the time of this visit the workmen exhibited some fragments consisting of white chert coated

* Fifth Annual Report, page 177.

with fine rhombohedrons of dolomite of the same reddish color as the rock at No. 11, with a few scattered cubes of pyrite, but they could not assign any definite horizon to them, saying they picked them out of the pumpings. They are probably from the reddish dolomite, but may be from the top of the sandrock when the passage from one to the other is apt to alternate from sandrock to dolomite in thin beds accompanied by chert................ 424 - 434 feet.

14. White quartz sand, rounded....................................... 434 - 481 feet.

15. White quartz sand, with traces of light green shale, and occasional small, aggregated, clustered, cubes of pyrite, the clusters being about the size of mustard seeds .... 481 - 504 feet.

16. White quartz sand, rounded, with some green shale. In mass this does not appear so clearly white as the last two, but a dirty white, apparently due to some soft, colored material ground up by the drill, which, on getting dry cements the sand grains into fragile lumps.. 504 - 558 feet.

17. White sand and green sand, the latter mainly ground to a fine powder, so as to stain the whole and make a greenish, fragile, loose mass, when dry. Some of the green sand is like the distinct green sand lumps seen in the St. Croix, at Red Wing.. .... 558 - 607 feet.

[The interval unrepresented by drillings, from 607 feet to 694 feet, probably was made up of the same as the last, or, perhaps, more like the next.]

18. White sand... 694 - 763 feet.

19. Mainly white sand, but having a mixture of other grains that are not silica, and of a heavy cementing substance that, when dry, seems to be a powdered rock of some sort, of a light buff and pinkish color. The mass, however, does not effervesce. Some scattered grains are green and soft, and may be the source of the coloring cement........................... .... 763 - 780 feet.

20. Green clay or shale; non-effervescing, very fine grained.. 780 - 935 feet.

21. White sand, with a faint yellowish tint...................... 935 - 1005 feet.

22. Siliceous sand, with a faint pinkish tint, rather fine......1005 - 1010 feet.

23. Siliceous sand, with a deeper pinkish tint, rather coarse grain, some of the grains being amethystine, and others of a light yellow color.. .1010 - 1060 feet.

24. Siliceous sand like the last, but of a lighter color ....1060 - 1105 feet.

25. The same, but cemented, when dry, with ground-up, reddish shale, probably derived from some beds introductory to the next...1105 - 1123 feet.

26. Compact, red clay, or shale, like that seen at Fond du Lac, below the red sand rock, and interstratified with it.... ....1123 - 1167 feet.

[At some places between 1123 and 1167 feet, several pieces of red shale, mottled with light green, were brought up by the pump. Some of these are two inches across. They are fine-grained, gritless, and sparkle with fine flakes of talc or mica. The green portions of this shale are finer grained than the red, and also are harder. The red has a powder that is reddish-umber in

color, and the green parts have a powder nearly white, or at least greenish-white. Within the green can be seen, under the loop, scattered, distinct grains, of much darker green, nearly black, which are about as hard as talc, and mash easily under pressure, with a greenish powder. The greenish shale seems to be subcrystalline. It occupies patches that are broad but thin, and constitutes but a small part of the whole; but it is intimately blended with the red in structure. According to Mr. Gray, this reddish-brown shale gradually became harder, and at 1235 feet it was a hard rock, and continued so to at least the depth of 1286 feet, where the drill was at work when this information was obtained.

At 1235 feet a somewhat harder stratum was reached. The drillings have a reddish color, but show angular fragments of gray or greenish slaty rock, soft, gritless, glittering with fine flecks and resembling Nos. 450 and 452 of the geological survey series (blue), but less hard. These fragments evidently show the nature of the rock at this depth, the red color of the drillings being caused by intermingling with material from the overlying beds, the well at this depth not being piped. Some of the fragments of gray or light green shale are an inch across. The sand grains, and all the reddish coloration, are undoubtedly from the higher strata. The gray-green shale is fragmental, not crystalline, except as it may contain grains from the crystalline rocks, glitters with light-colored scales of mica, macerated by water and friction, and also holds rounded grains of a green substance, which outwardly is nearly black but within is much lighter, and which mashes easily, evidently the same substance as mentioned already.]

27. Reddish-brown schist, hardness about four and one-half or five, with a gray streak or powder, glistening with reflecting, minute points of some mineral which it is impossible to name, but which may be mica scales. This has the general outward aspect of an impure hematite, but its powder and its weight show it is not an iron ore of any kind. On washing a considerable quantity of the drillings from this interval (really labeled from 1260 – 1380 feet), the residue consists of grains of a great variety of rocks, demonstrating that great care must be taken in drawing inferences from the appearances of the drillings furnished by the usual well driller, and that the drillings from the upper portions of the well are constantly mixed with those derived from below, in such abundance often as to screen entirely the true character of the lowest strata from the notice of the geologist. The grains in this instance consist of the following kinds: (1) Conspicuously, white, limpid sand. (2) Brown schist, with a gray or light streak, making the greater part. (3) Soft greenish slate. (4) Red, soft shale with spots of green. (5) A few bits of an arkose-like sandstone, with a pea-green interior color. (6) A gray, hard, fine-grained schist, not foliated like (2), but having an angular

fracture, as if massive, and (7), A single, large piece, of a dark, medium-grained, massive rock, like a dioryte. These last, (6 and 7), evidently are from near the bottom of the drill, as they are the last to appear among the drillings................1167 - 1400 feet.

SUMMARY OF THE WELL DRILLED AT THE LAKEWOOD CEMETERY.

1. Drift, 1 - 256 feet.. 256 feet.
2. White sandrock, 256 - 318 feet........................ 62 feet.
3. Dolomitic rock, 318 - 403 feet........................ 85 feet.
4. White quartz sandrock, 403 - 504 feet........... 101 feet.
5. White quartz sand and green sand, 504 - 780 ft. 276 feet.
6. Green clay or shale, 780 - 935 feet.................. 145 feet.
7. Siliceous sand, yellowish or pinkish, 935 - 1105 feet.. 170 feet.
8. Soft red shale and sandstone, with greenish mottlings, has red powder, 1105 - 1167 feet... 62 feet.
9. Harder, reddish-brown rock, not arenaceous, a schist, has light gray powder, 1167 - 1400 feet.. 233 feet.

The boring ceased at 1400 feet.

The drilling of this well was subsequently continued to the depth of —— feet. At 1860 feet the washed drillings consisted largely of white, limpid, rounded quartz grains, from above, and of a gray, tough crypto-crystalline rock, which showed the nature of the rock at that depth, resembling many of the strata seen in the rocks at Thomson and thence to Knife Falls, of which the survey numbers four hundred and sixty-nine and four hundred and seventy-three might be mentioned. Some larger fragments were black and graphitic, and throughout the whole were numerous battered films of metallic iron from the drill.

VIII.

NOTES ON THE ARTESIAN WELLS AT MENDOTA, HASTINGS, RED WING, LAKE CITY AND BROWNSVILLE, AND ON THE DEEP WELLS AT ST. PAUL.

The well at Mendota was drilled by W. E. Swan, and the following designations are his. The point at which the well begins is sixty-five feet above the Mississippi river, within the river gorge, and so near the rock bluff composed of the Trenton limestone and the St. Peter sandstone that the drill encountered some of the old, fallen masses of the limestone at some depths below the top of the St. Peter, which is visible in the immediate bluff about fifty feet distant. The St. Peter sandstone rises forty-seven feet above the top of this well. The top of the well is about seven hundred and fifty feet above the sea.

No. 1.	Limestone. [Fallen masses of the Trenton — N. H. W.]	22 feet.
No. 2.	Brown sandrock	60 feet.
No. 3.	Blue shale	30 feet.

[This, which here is designated blue shale, is probably not all blue shale. It holds the place of the Shakopee limestone, and is about on the horizon where the known upper strata of that formation, about a mile east of Hamilton, with the theoretical dip that must be assumed toward the northeast, would require the Shakopee. The Shakopee everywhere in Scott and Dakota counties causes remarkable bogs, indicating the impervious, shaly nature of the formation. Moreover, it becomes arenaceous, as well as shaly, as may be seen at Northfield. Its firmness, under erosion, is reduced by these qualities, and it also is less frequently seen — N. H. W.]*

*According to Rev. James Dobbin, the following alternations of strata were found in sinking a well at the Shattuck School, Faribault, indicating that the top of the Shakopee there was found to be a blue clay 5 feet thick: Clay soil, 9 feet; limerock, 21 feet; sandrock, 117 feet; stiff, blue clay, 5 feet; fine, brown sand, 3 feet; striking a very hard stone, which was regarded granite, but which was probably the firmer dolomitic beds of the Shakopee, which can be seen in the valley ofthe Cannon river, a few miles further north, and near the Cannon Valley roller mill.

No. 4.	Sandrock	35 feet.
" 5.	Magnesian limestone	145 "
" 6.	Sandrock	95 "
" 7.	Gray shale	50 "
" 8.	Green shale	110 "
" 9.	Limestone	10 "
" 10.	Blue shale	30 "
" 11.	Sandrock	50 "
" 12.	Gray shale	40 "
" 13.	Green shale	35 "
" 14.	Very hard red sand rock, enclosing beds of red shale	145 "
	Total	857 feet.

"No. 5 of this well seems to be the same limestone that outcrops at Hastings. We struck a crevice when we got 40 feet into this stratum, from which the water began to flow at the rate of 40 gallons per minute. A second flow of water was obtained from No. 11 (sandrock). When we got through that sandrock, the well flowed 300 gallons per minute. After we got through drilling we tubed the well and separated the upper vein of water from the lower vein, and we found the lower water to be much softer than that which comes from the upper vein. We also found that the water from the lower vein rose 14 feet above the surface, while that from the upper vein would only rise 4 feet. No water was obtained from the red sandrock (No. 14); there was no increase in the flow after passing through No. 11."

The Hastings deep well was drilled by W. E. Swan, and the information here given respecting the character of the strata is derived from his notes and from a series of the preserved drillings which he has furnished. This well is located at the depot of the Chicago, Milwaukee and St. Paul railway, about seven hundred and ten feet above the sea, and about ninety feet below the top of the St. Lawrence limestone as exhibited in the bluffs adjoining. The water rises fourteen feet above the surface.

1.	Dolomitic limerock. *St. Lawrence*	80 feet.
2.	Sandrock	15 "
3.	Dolomitic grit, (Mr. Swan designated this limestone)	12 "
4.	Sandrock, supplying no water [Some of this is coarse and some is fine. In the lowest ten feet the drillings contained fragments and rusty tubes that recall the tubes in the St. Peter sandstone described in Vol. 1. p. 656, but these are much firmer.]	95 "
5.	Sandy shale, white, mostly sand	25 "
6.	Gray shale, with much sand and some dolomite	43 "
7.	Green shale, *i. e.* sand and green sand	20 "
8.	Green shale, probably pulverized green sand	110 "

9.	Sandy shale, sand and green sand	15 feet.
	[Nos. 6, 7, 8 and 9 may all be described as sand and green sand.]	
10.	Sandrock with a few lumps of iron pyrite	20 "
11.	Sandrock with a few lumps of iron pyrite	20 "
12.	Sandrock with more iron pyrite; first flow of water	20 "
13.	Gray, sandy shale	20 "
14.	Blue shale	70 "
15.	Sand and pulverized green sand	20 "
16.	Dolomitic grit with gray shale and sand	5 "
17.	Sand rock with lumps of iron pyrite and dolomitic grit Second flow of water	5 "
18.	Sandrock with some pyrite	25 "
19.	Sandrock, coarse	10 "
20.	Sandrock	10 "
21.	Sandrock, coarse	10 "
22.	Sandrock	100 "
23.	Sandrock, coarse	30 "
24.	Sandrock, fine and coarse, some grains one-quarter inch in diameter, one of black quartzite, with traces of red shale	40 "
25.	White quartz sand, mixed with pinkish, apparently orthoclose sand, and some grains of red and black quartzite	30 "
26.	Red shale, with some white quartz sand	20 "
27.	Red and white sand with pieces of battered metallic iron, doubtless from the drill	15 "
28.	Red shale	40 "
29.	Mainly white quartz sand, but tinted red by bits of shale and other red grains; contains bits of metallic iron	75 "
30.	The same but more red	50 "
31.	The same; the shale is soft and has a red powder, like hematite	110 "
	Total depth	1160 feet

This well flows about one hundred gallons per minute and raises the water fourteen feet above the surface. There seems to be a very small portion of salt in the water. We all expected to get a large flow at Hastings, and were greatly disappointed at the result.

The Red Wing well is at and on the same level as the depot of the Chicago, Milwaukee & St. Paul railway and hence six hundred and eighty-seven feet above the sea. It was drilled by Mr. W. E. Swan, and the information below is derived entirely from him. It begins and ends in the St. Croix formation.

No. 1.	Sand and gravel	40	feet.
" 2.	Sandy shale	10	"
" 3.	Blue shale	50	"
" 4.	Sandrock	10	"
" 5.	Blue shale	30	"
" 6.	A mixture of sand, quartz and limerock	45	"
" 7.	Soft sandrock	265	"
	Total	450	feet.

"This well flows eight hundred gallons a minute at the surface, above which its water rises, when confined in a pipe, to the height of seventy-five feet. It is the largest flow for the depth that I have seen in my experience of twenty-one years. It began to flow over at one hundred and ninety feet from the surface and kept on increasing to the end. We stopped drilling in [at] the red sandrock. I have no faith in getting an increase of water after we strike it, as it always gets very hard, so that we cannot drill more than sixteen feet in twenty-four hours, while in the sandrock where we get our flow, we have sometimes drilled from five to fifteen feet an hour." *

The Well at Lake City was also drilled by Mr. W. E. Swan. He has supplied the survey with a series of the drillings in bottles. His designations were published in the Museum report for 1881, [tenth annual report, p. 161], and are here repeated with such corrections as a study of the drillings requires. This well passes through a considerable thickness of drift, showing the great depth of the Mississippi gorge at that place, being at least two hundred and ten feet below the top of the well. The depot at Lake City is seven hundred and five feet above the sea. and this well is on the same level, and forty-one feet above the low water level of lake Pepin. The well begins in the St. Croix formation.

1.	Black soil	2	feet.
2.	Yellow clay	40	"
3.	Gravel and sand	160	"
4.	Fine loam-clay	5	"
5.	Sand, this seems to be the beginning of the rock	18	"
6.	Coarse sand	7	"
7.	Sand	208	"
8.	Sand, rusty or stained with light red shale	5	"
9.	Sand, very coarse, white grains often fractured	15	"
10.	Sand, stained with red shale, and with flesh red grains	35	"
11.	Sand.	5	"
12.	Red shale and sand; shale is soft and has a red powder...	230	"
	Total depth	820	feet.

* Col. Wm. Colvill says that at Christ's Brewery, Red Wing, is a deep well that spouts three hundred barrels per day, rising thirty feet above the surface—one hundred and sixty feet in drift and one hundred feet in sandrock—eighty rods west of the Milwaukee depot and three rods south of the track and thirty feet above it.

The artesian well at Brownsville, in Houston county, was an experiment for increasing the supply of water to the grist mill of Messrs. Shaller Brothers. According to Mr. Swan, who drilled the well, the discharge is 1,000 gallons per minute, soft water, and granite was reached at 590 feet, where the work ceased. The mouth of this well may be 25 feet above the Mississippi river, or 650 feet above the sea, and the water rises 12 or 14 feet above the surface of the ground. The Potsdam seems here to have been wanting, and the St. Croix deposited unconformably upon the granite.

No. 1.	Blue clay	40 feet.
No. 2.	Limestone. [Doubtful, probably a dolomitic grit — N. H. W.]	25 feet.
No. 3.	Blue shale	60 feet.
No. 4	Green shale	70 feet.
No. 5.	Sandrock	395 feet.
	Total	590 feet.

The first well drilled at the St. Paul Harvester Works, in 1882, was in the rattling, or chipping, room of the foundry, at a height of about fifteen feet above Phalen creek near by, or about 863 feet above the sea.* This well was drilled by N. W. Cary, to the depth of 582 feet (claimed by Mr. Cary to be 602 feet), when his work ceased. In the winter of 1882-3 it was continued, by a diamond drill, under the management of Joseph Susor, to the depth of 626½ feet. The only samples preserved from this well, so far as known, were from the part drilled by Mr. Susor. They are from 10, 20, 30, and 44 feet below 582 feet. These are pulverized, darkish gray, shaly, siliceous, probably dolomitic, agreeing with the core obtained from the second well at a corresponding depth. Owing to the supposed bed of iron and iron ore (reported to be very hard to drill), in the first well *a second one was drilled,* at a point about fifteen rods north from the first, on land about eight feet higher, or approximately 871 feet above the sea. Mr. Cary drilled in this well, during the summer and autumn of 1882, to the depth of 515½ feet. Mr. Susor, with a diamond drill, penetrated 156 feet further, or to a total depth of 671½ feet. A very complete set of the samples from this well

*The railroad at the Union Depot, St. Paul, is 701.5; water in Phalen creek, at the highest crossing of the St. Paul, Stillwater and Taylors Falls Railroad, 845; water in this creek at the Harvester Works, 848; Phalen lake, 854. Concerning the alleged discovery of a deposit of metallic iron and magnetic iron ore in this well, beginning at the depth of 560 feet, and reaching below at least 42 feet, see the *Pioneer Press* for August 24, 1882.

were courteously supplied by Mr. Kirk, from the drillings preserved in the office of the Harvester Works at St. Paul. Mr. Cary drilled a hole six inches in diameter; the core obtained by the diamond drill is about an inch in diameter. The water stands constantly in each well at 35 or 40 feet below the surface. The following descriptions of these drillings are essentially as prepared by Mr. Upham. Rock was reached at 235 feet.

No. 1.	Dark, sandy and clayey loam	1–10	feet.
" 2.	Gray sand and fine gravel containing pebbles up to three-quarters of an inch in diameter	10–20	"
" 3.	Same, with pebbles up to one and a half inches in diameter	20–30	"
" 4.	Yellowish coarse sand	30–40	"
" 5.	Yellowish sand and gravel, with pebbles up to one-half inch	40–50	"
" 6.	Yellowish sand and fine gravel	50–60	"
" 7.	Light gray sand and fine gravel	60–70	"
" 8.	Light gray sand and fine gravel	70–80	"
" 9.	Light gray sand and fine gravel	80–90	"
" 10.	Light gray, fine sand and pebbles up to one and one-half inches, slate, greenstone, etc.	90–100	"
" 11.	Light gray, fine sand and pebbles up to three-quarters of an inch, including some of granite	100–110	"
" 12.	Light gray sand and gravel, with small pebbles of granite, greenstone, etc.	110–120	"
" 13.	Light gray sand and gravel, with small pebbles up to one-half inch	120–130	"
" 14.	Light gray sand and fine gravel	130–140	"
" 15.	Light reddish gray sand, with rare green stone pebbles up to one and one-half inches in diameter	140–150	"
" 16.	Light reddish gray sand, with pebbles (rare) up to two inches in diameter	150–160	"
" 17.	Light reddish gray sand, with pebbles up to one and one-half inches	160–170	"
" 18.	Light gray sand, with pebbles up to one inch in diameter	170–180	"
" 19.	Coarse gravel, largely made up of pebbles (from the northeast) up to one and one-half inches	180–190	"
" 20.	Similar to last but containing more sand intermixed	190–200	"
" 21.	Same, mostly finer, but with occasional pebbles up to two inches, (one a reddish porphyry, from Lake Superior)	200–210	"
" 22.	Coarse gravel, mostly pebbles up to two inches, with little sand	210–220	"
" 23	Yellowish sand, with few gravel stones, (these probably from the stratum above)	220–230	"

" 24.	The pulverized drilling contains a large proportion of broken, angular fragments (up to one-third of an inch) of buff magnesian limestone (with some sand and gravel stones); the rock is said to have been struck at two hundred and thirty-five feet	230–240	"
" 25.	Light yellowish, very fine powder, slightly caked in the box, including no coarse particles or fragments; effervescing freely	240–250	"
" 26.	Light buff; drillings intermediate in character between the last two	250–260	"
" 27.	Similar to last, but more arenaceous, mainly very fine, granular (fractured), angular (also containing sand and occasional small pebbles, doubtless from above two hundred and thirty-five)	260–270	"
" 28.	Light buff magnesian limestone, in fine (from dust up to one-twelfth of an inch) angular fragments, with grains of rounded quartz	270–280	"
" 29.	Magnesian limestone, yellowish buff, containing a considerable proportion of white quartz particles, some of them rounded by water, up to one-twentieth of an inch in diameter, with arenaceous chert and quartz geodes	280–290	"
" 30.	Mostly very fine yellowish powder (dust) nearly like No. 25, but also containing frequent angular particles up to one-quarter of an inch in diameter, of magnesian limestone	290–300	"
	[The samples from three hundred to three hundred and fifty were wanting and could not be found nor learned of. This part is probably limestone, which lies both above and below.]		
" 36.	Mostly fine, light gray powder, with angular fragments up to one-eighth of an inch, of fine grained magnesian limestone that effervesce freely	350–360	"
" 37.	Sandstone; light yellowish, fine, largely (half or more) composed of white quartz grains, well rounded, up to one-thirtieth of an inch in diameter, with dolomitic powder	360–370	"
" 38.	Limestone; light yellowish buff, nearly like No. 36, excepting color	370–380	"
" 39.	Sandstone; light gray; all the grains water-rounded mostly one-sixtieth to one-twentieth of an inch in diameter, or finer; none coarser than one-twentieth of an inch	380–390	"
" 40.	Same as last, mostly beautifully rounded white quartz grains, with pieces of coal, metallic iron and furnace slag	390–400	"
" 41.	Same as last, becoming more yellowish, with a few bits of coal and battered scales of metallic iron	400–410	"
" 42.	Same, with a few grains of shining black coal and scales of metallic iron, the latter largely oxydized	410–420	"

" 43.	Same, but finer and whiter; grains not exceeding one-fortieth of an inch, all well rounded, with some pyrite, and a few iron scales..................................	420–430	"
" 44.	Same as last; very light yellowish, with slight traces of coal and iron scales..	430–440	"
" 45.	Same as the two preceding, with a few grains of pyrite with grains of rounded quartz firmly cemented to them and scales of iron...	440–450	"
" 46.	Still finer water-worn sandstone, very light gray, almost white...	450–460	"
" 47.	Coarse (up to one-twentieth of an inch), with much also that is very fine; yellowish gray; well water-worn, with iron scales (rusted) and grains of a black scoria; also contains traces of green shale and some dolomitic powder	460–470	"
" 48.	Very fine; very light yellowish; well rounded; much like No. 46, with coal (anthracite), one piece being three-tenths of an inch in diameter; scoria and scales of iron..	470–480	"
" 49.	Very fine; light leaden gray, arenaceous (and perhaps dolomitic) shale; (caking somewhat in the box) effervesces..	480–490	"
" 50.	Very fine (more so than last) light dusky gray, arenaceous shale; caking harder than the last..............	490–500	"
" 51.	Similar to the last but more arenaceous, with much sand of white quartz, up to one-hundredth of an inch in diameter..	500–515	"

[At five hundred and fifteen feet the pulverized drillings stop, and the remainder of this well is represented by samples of the core of the diamond drill, about one inch in diameter.]

Core from Diamond Drill.

At 555 feet. "Core at 40 feet (six inches" of core).	Gray, compact and hard, fine-grained sandrock, probably dolomitic; inclosing occasional shaly, darker laminae, and having in some portions dark specks of greensand.
At 578 feet. "Jan. 1st, 1883; at 63 ft.,—18 inches of core."	Same as the preceding.
At 590 feet. "75 feet — 12 inches of core."	Light yellowish buff, compact and hard, very fine grained sandrock, probably dolomitic; containing mica scales (?) [very minute shining facettes]; (not shaly and having less greensand.)
At 626 feet. "111 feet — 11 inches of core."	Similar to the last, but with light green streaks and irregular blotches, up to one-quarter of an inch thick, vertically, yet not more than three-quarters of an inch long, thinning at each side to one-twentieth of an inch or less in thickness; some fine shale.

At 650–660 feet. "Jan. 8th. This is from 135 to 145 feet. JOSEPH SUSOR." (About 5 feet of core.)	Hard and compact, alternately arenaceous and shaly, probably dolomitic; in color about one-tenth part buff; about one-half dusky gray; and about two-fifths dark green. The layers of dark greensand not so hard as the other portions, vary from one twentieth of an inch to two or three inches in thickness, being interbedded with the dusky and buff layers

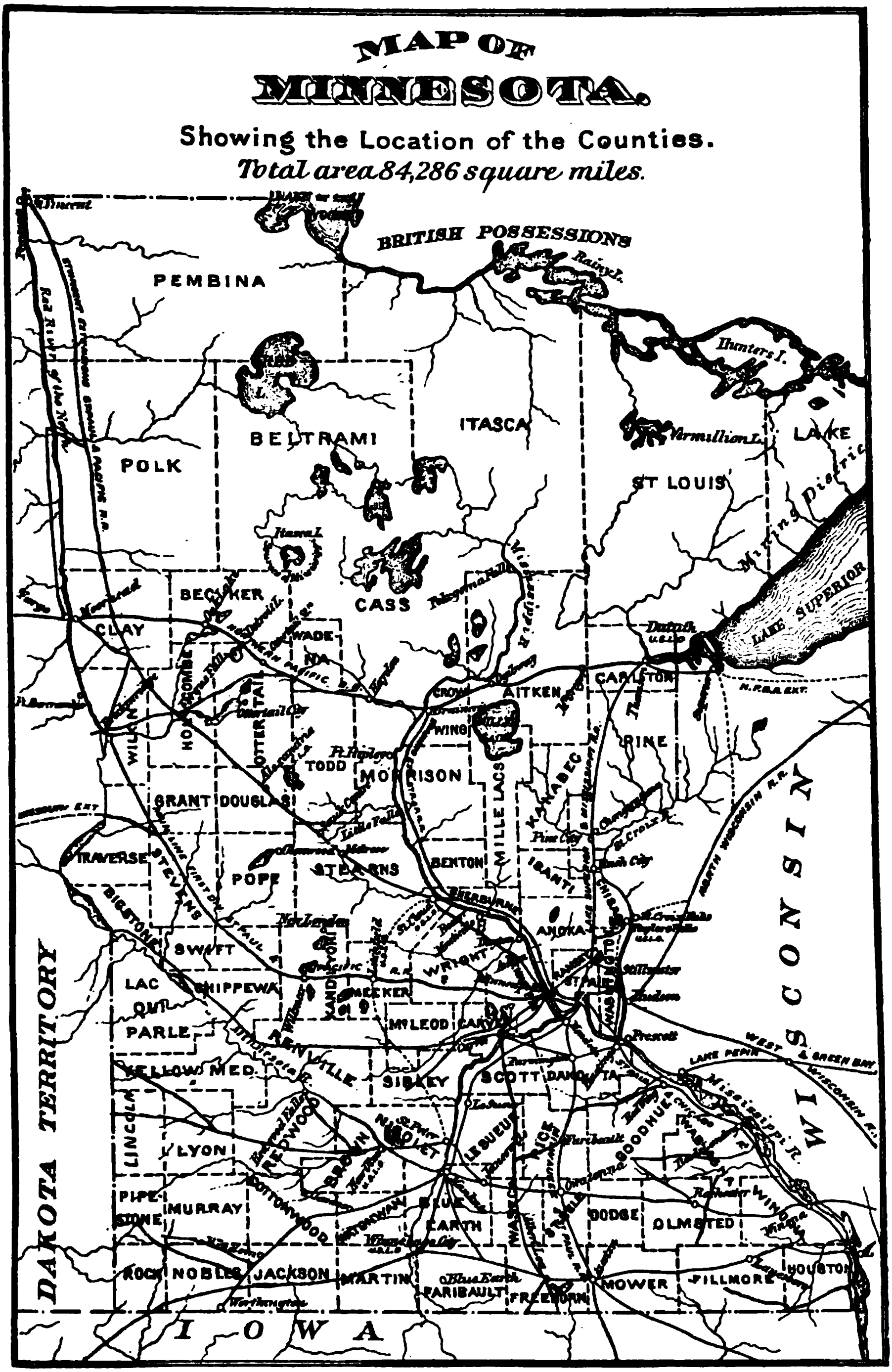
The deep well at Elevator B., St. Paul, is situated near the centre of the southwest quarter of the southeast quarter of section twenty-five, about three and one-half miles west from the Harvester Works wells, beginning about eight hundred and fifty-five feet above the level of the sea. The drillings from this well were examined by Mr. Upham, through the courtesy of Mr. W. S. Zimmerman. The entire depth is eight hundred and fifty feet, drilled by N. W. Carey. Water stood at thirty-five feet below the surface during the entire progress of the work.

1.	Dark gray, fine sand, at 40 feet.		
2.	Dark gray, fine sand	40–58	feet
3.	Light gray, shaly limestone	58–63	feet.
4.	The same	63–69	"
5.	Light yellowish gray, very fine grained, arenaceous (?) shaly	69–83	"
6.	Fine grained, white sandstone	83–235	"
7.	Light gray; somewhat argillaceous, fine grained, apparently sandstone	235–265	"
8.	Buff magnesian limestone in angular fragments	265–300	"
9.	Fine grained, white quartz sandstone, water-rounded	300–320	"
10.	Buff magnesian limestone	320–335	"
11.	Fine, light yellowish powder, no grains visible	335–375	"
12.	White sandstone, in small part iron rusted, water-rounded	375–436	"
13.	Light buff, gritty stone, like the core of the diamond drill in the Harvester Works well	436–437½	"
14.	Sand, light gray, or nearly white	437½–478	"
15.	Light gray shale	478–515	"
16.	Very fine bluish shale	515–523	"
17.	Very fine, light gray shale	523–529	"
18.	Very fine, light yellowish gray sandstone, somewhat argillaceous	529–540	"
19.	Very fine sandstone, with some dark green grains	540–560	"
20.	Very fine shale. olive green	560–589	"
21.	Nearly the same as the last, with some sand	589–604	"
22.	Light gray shale, with some sand	604–672	"
23.	Fine grained sandstone, dark gray	672–738	"
24.	Light gray shale, very fine grained	738–761	"
25.	Unknown	761–850	"

The well at the Harvester Works apparently struck the St. Lawrence, the depth to the rock indicating the absence of the Shakopee and Jordan. The well at Elevator B exhibits some irregularity. The "blue shale" which at Mendota seems to represent the Shakopee, below a thickness of a hundred and twenty-nine feet of sandstone (including forty-seven feet visible in the face of the bluff), is not mentioned at all. It may have been passed without being noted in the one hundred and fifty-two feet reported as sandrock, or it may be represented by Nos. 7 and 8. In the latter case it would coincide with the recognized dip of the Trenton between Mendota and Elevator B, which amounts to about twenty-five feet, bringing the top of the Shakopee at Mendota at about six hundred and fifty-five feet above the sea level, and at Elevator B six hundred and twenty feet. The underlying white sand (twenty feet) would be the Jordan, which in the Mendota well is reported to be thirty-five feet. This parallelism, however, requires the reduction of the St. Lawrence from one hundred and forty-five feet, reported in the Mendota well, to fifty-five feet as reported in the Elevator B well. The same stratum at Lakewood cemetery is given at eighty-five feet.

Any person who has had occasion to record and compare the reports of well-drillers, or to obtain the drillings of wells for his own examination, will appreciate the difficulties and the uncertainties of such records. The drillings are not carefully preserved; the depths from which they are obtained are not accurately stated, nor even known, and the changes in the rock from stratum to stratum cannot be located with precision. Some broad stratigraphic distinctions can generally be made out.

In the case of the wells foregoing it seems necessary to state that the Shakopee formation dwindles toward the north and northeast in this latitude, as already well known further south. The sandy and clay constituents increase at the expense of the calcareous. This is true also of the St. Lawrence, which at Hastings, and apparently at Stillwater, embraces one or more strata of white sand from ten to twenty feet in thickness. These are comparable to these thinner beds of white sand that are intercalated in the Shakopee, seen at Northfield.


MAP OF
MINNESOTA.
Showing the Location of the Counties.
Total area 84,286 square miles.
BRITISH POSSESSIONS
PEMBINA
BELTRAMI
ITASCA
POLK
ST LOUIS
LAKE
Hunters I.
Vermillion L.
Rainy L.
Itasca L.
BECKER
CLAY
WADENA
CASS
CROW WING
AITKEN
CARLTON
Duluth
LAKE SUPERIOR
PINE
KANABEC
MILLE LACS
MORRISON
TODD
OTTER TAIL
WILKIN
GRANT
DOUGLAS
TRAVERSE
STEVENS
POPE
STEARNS
BENTON
ISANTI
ANOKA
SHERBURNE
BIGSTONE
SWIFT
WRIGHT
LAC QUI PARLE
CHIPPEWA
KANDIYOHI
MEEKER
McLEOD
CARVER
RENVILLE
SIBLEY
SCOTT
DAKOTA
WASHINGTON
YELLOW MED.
LINCOLN
LYON
REDWOOD
BROWN
NICOLLET
LE SUEUR
RICE
GOODHUE
WABASHA
PIPE STONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
Worthington
DAKOTA TERRITORY
IOWA
WISCONSIN
NORTH WISCONSIN R.R.
WEST WISCONSIN R.R.
LAKE PEPIN
Mississippi R.
Prescott
Hudson
Stillwater

IX.

FOSSILS FROM THE RED QUARTZYTE AT PIPESTONE.

About the middle of October, on the occasion of a visit to Pipestone to obtain specimens for the World's Cotton and Centennial Exposition at New Orleans, in a cursory examination of a lot of the pipestone material in the possession of Mr. C. H. Bennett, certain markings were noticed that had the aspect of small fossil shells, and on some further search several slabs were found which had great numbers of the same impressions thickly scattered over the surface of the bedding side. Subsequently other slabs were found at the Indian quarry which had the same marks freshly exposed by recent operations at the quarry.

These fossils occur in the blood-red catlinite, which is the only kind used by the Indians, though it is possible that they can be found also in the light-colored slabs. They consist of thin lenses about six millimetres in diameter, imbedded in the otherwise homogeneous pipestone. They might be taken for inorganic flattened concretions were it not that they exhibit indistinctly some evidences of organic structure, and when they are removed, along with more or less of the pipestone material, the portion removed, embracing the powdered white scales, shows, on chemical analysis, the presence of phosphate of lime.

Subsequently Mr. A. W. Barber, of Yankton, Dakota, found a trilobitic form among the debris of the old Indian quarry, and it is described below, with his name, as a specific designation.

LINGULA CALUMET.

The shell, so far as can be determined by the fossil remains, was very thin and fragile, containing some phosphate of lime, and nearly circular, averaging somewhat less than a quarter of

an inch across. When freshly uncovered it is of a light flesh color, and resembles the light colored spots that have often been mentioned in the blood-red catlinite, but is much lighter. That these light spots, however, are distinct from those, and different, is evident at a glance. Those light spots have no constant form nor size within the rock. They vary from the size of pin-points to areas covering several inches. They are not so related to the structure that they are uncovered by splitting the rock along its bedding planes, but are as likely to be exposed by a fracture across the bedding. They do not wear away readily by friction, but enter the mass of the rock, while these are so thin that a short exposure to the weather destroys them, leaving only the outline of the shell, either the interior or exterior, outlined in the blood-red catlinite. A section across them is all of the same color; that across these shows a thin scale of the light colored matter embracing a small lenticular mass of the same aspect as the main mass of the rock, of a blood-red color. Those are disseminated porphyritically through the mass of the rock; these lie only in thin sheets (apparently only in one plane) coincident with the bedding, their flatness being in that direction in which a thin bivalve would necessarily lie on the bottom when acted on by sedimentation.

These lenticular bodies, when both valves are preserved in apposition, are about one-half millimeter in thickness; and when only one valve is present there is only the form of the shell preserved, with the merest trace of a scale, that probably represents the shell itself.

There is in some instances a very indistinct, rude, lamellose, concentric marking on the exterior. On the interior of the valves, *i. e.*, on the concave impressions, there is quite frequently a distinct, marginal, flat band, which is separated from the central part by a faint ridge. This ridge may have marked the limit of the general visceral cavity.* The beak of the longer valve is rarely seen in its prolongation beyond the other valve; but there is very often an impression that shows a decided elongation of the shell, such that it could not be described as circular. The smaller valve approaches nearer the circular form. The following figures show some of these features, magnified two diameters. Most of those indistinct markings are similar to

* The appearance of this marginal ridge, in its undulating course, is very similar to that represented in *Obolus Apollinis*, by fig. 282, pl. ix, of Davidson's Introduction to British Fossil Brachiopoda, vol. 1.

those of *Lingula inchoans*, Barr., illustrated by figures 74 and 75 of Barrande's *Faune silurienne des environs de Hof*, en Baviere. This shell, however, is about double the size of that.

EXPLANATION OF FIG. 6.—PLATE I.

Fig. a. Impression of the beak of the longer valve (concave).
Fig. b. Impression of the shorter valve (concave).
Fig. c. Convex surface of a small specimen.
Fig. d. Concave impression of the longer (?) valve.

Locality and position. In the catlinite at the great pipestone quarry, in Pipestone County. Museum register number, 5559. Collector, N. H. Winchell.

PARADOXIDES BARBERI. (N. SP.)

The specimen found by Mr. Barber has been crushed and folded upon itself by some pressure obliquely applied from the right and somewhat from the rear, so that the pleuræ of the left side are turned underneath the animal, but exhibit their furrows and ridges alternately to the number of fourteen or fifteen furrows, separated by as many ridges. The segments of the axis are thus thrust forward over the crumpled pleuræ of the left side, showing more or less of the articular portion of several of the segments. The specimen shows but slight traces of the original crust of the animal. At several places, however, and particularly in the sheltered joints along the axal furrows, small fragments of a thin, red, shining covering remain. The specimen has long been weathered. It is much roughened by the exposure, and injured as a fossil by this fact. It has been in contact with the camp fires of the Indians, as evinced by the blackened condition of the under surface.

The cephalic shield, including the glabella, is wanting; but there are two or three furrows that can be seen to cross the anterior portion of the specimen, as if due to the original furrows of the glabella, and another terminates before reaching the middle. Whether this termination of one of these furrows be due to the pushing together and overlapping of the segments under oblique pressure, or to an actual and natural character of the shield, cannot be ascertained. The whole left side, and much of the central lobe, throughout the thoracic portion, are obscured by the same accident. The accompanying figure (7) of plate I. ex-

presses the character of this fossil better than any description that can be written of its visible characters. About fourteen ridges can be counted on the under side, expressing the number of the pleuræ folded beneath. But in advance of these fourteen are about two more on the upper surface, some of them exhibiting a tendency to duplication, caused by the pleural grooves. The thoracic segments may be considered to have reached sixteen, at least. On the right side from twelve to fourteen segments can be counted, although there are several that are narrow and seem to be due to the crushing down of the right side by an oblique pressure on the pleural grooves.

It is possible that this specimen belongs to some described species, but it would plainly be premature to assign it to any known species at present. It is thought best to give it the name of Mr. A. W. Barber, who discovered it, and await the finding of better material to correct any error. The figure is drawn of the natural size.

Position and locality. The catlinite layers at Pipestone; collected by A. W. Barber. Museum register number, 5555.

The following letter was received from Mr. S. W. Ford, who for some years has been at work on a similar fauna found in eastern New York, and is familiar with obscure forms of organic remains under such circumstances.

S. W. Ford on the pipestone fossils.

SCHODACK LANDING, RENSSELAER COUNTY, N. Y.,
February 14th, 1885.

Prof. N. H. Winchell,

MY DEAR SIR: I have examined with deep interest, and on several different occasions, the supposed fossils from your "red pipestone" rocks of Minnesota, which you kindly submitted to me for study, and have no hesitation in pronouncing them organic. I have endeavored to study the specimens without bias or prejudice; indeed I think I can safely say that my mind has been uninfluenced by any prepossessions concerning the age of the terrane affording them, although aware from the perusal of your writings, as well as those of others, that the disposition has been rather strong of late years, to rank the quartzite as "Huronian."

Your principal specimen (No. 5555) I believe to be a trilobite and most probably a *Paradoxides*, although it may possibly represent the somewhat newer primordial genus *Olenellus*. The specimen has been distorted by pressure exerted obliquely across it from behind, forcing the extremities of the left hand posterior pleuræ underneath and diagonally across the body-axis, and

carrying the axis itself a little to the left. The cephalic shield is wanting. There appear to be from twelve to fourteen body-rings represented, and there are indications that the higher of these figures would be below the actual number in the individual if complete. Along the forward left hand portion of the specimen, there are patches of what I believe to be the altered test of the creature still remaining. The thickness of these films agrees well with the known thickness of the test in trilobites of the genera *Paradoxides* and *Olenellus*. I may add that I also noticed in my study of the body-rings evidences of the usual "articular folds" of trilobites.

The other specimens appear to me to be most probably *Lingulæ*, and the examples to which I have attached tags, or pointers, seem decisive upon this point.* But what the species may be I have no idea. The specimens are all in the condition of casts, and although at first disposed to think that the peculiar pitting noticed in the rostral portion of some of the examples, pointed to *Siphonotreta*, I have since been able to satisfy myself that they are only the casts of sand grains in the pipestone. I have in my collection from the "Acadian" of New Brunswick, slabs crowdedly covered with *Lingulæ* of small size which strikingly suggest a like age for your specimens, and while I cannot feel sure of my position, owing to the imperfection of the materials studied, I am, nevertheless, strongly impressed with the belief that your red "pipestone" fossils are most probably "Acadian."

It affords me much pleasure to add that the results of my examination of your specimens sustain, for the most part, the views you were disposed to take of their generic relations, as expressed in your letter of the sixth instant, accompanying them.

Thanking you for your courtesy and kindness,

I remain, dear Professor,

Very truly yours,

S. W. FORD.

The following is an extract from a letter from Prof. J. D. Dana, respecting these fossils:

NEW HAVEN, CT., February 25, 1885.

Prof. N. H. Winchell,

DEAR SIR: I am much pleased to have had the privilege of seeing your catlinite fossils. There appears to be no mistake about them, and the little, nearly circular shell, is, as you say, closely like *Lingula*, as far as its characters are discernible. The trilobite might be considered a doubtful fossil, or doubtful whether or not a fossil, were it not associated with other species. But as the case stands there is no good reason for doubting it, and it is an exceedingly interesting find. I believe in fixing the age of even crystalline rocks by fossils, and that has been my heresy; and I am glad that you are having success in that direction. There are some Archæan rocks that have Archæan stamped on them — those that contain chondroditic limestones, and abound in hornblende, scapolites and zircons. But many of them are of ambiguous character, and need to have somewhere an overlying bed of unmistakable primordial (Cambrian) to make their Archæan age certain. . . .

Yours truly,

JAMES D. DANA.

* One of these is b of figure 6, plate I.—N. H. W.

It is well known, from the researches of Wm. E. Logan and T. Sterry Hunt, that the composition of the shells of recent and fossil Lingulæ is made up to a considerable extent of phosphate of lime.* For the purpose of comparison a specimen was handed to Prof. Dodge, who has made the following report:

Prof. James A. Dodge, on the composition of the shells of the fossil Lingulæ from Pipestone.

THE UNIVERSITY OF MINNESOTA,
CHEMICAL LABORATORY.

MINNEAPOLIS, MINN., Feb. 11, 1885.

Prof. N. H. Winchell,

DEAR SIR: I have made an analysis of the white shell-like substance found on the surface of a specimen of pipestone (Chem. series No. 173), as requested by you a few days ago. I find it to consist *esentially of carbonate of lime* but with distinct *traces of phosphate of lime.*

Very respectfully yours,
JAMES A. DODGE.

The discovery of primordial fossils in the pipestone of Minnesota makes an important datum for calculating the stratigraphy of other rocks of the Northwest. This "pipestone" is a part of the great series of quartzytes which by C. A. White was styled *Sioux Quartzyte* in his final report on the geology of Iowa, in 1870. These quartzytes are conspicuous at several other places in Minnesota, and also in Wisconsin, where they have been denominated *Baraboo quartzyte* and placed in the "Huronian." Prof. James Hall, in 1867, and Mr. J. H. Kloos, in 1871, classed the quartzytes of southwestern Minnesota in the "Huronian." These fossils place them within the "primordial zone" of Barrande, a geological stage which has not yet, confessedly, been covered by the term "Huronian" at any point in America. The Paradoxides horizon, which seems to be here indicated, has been distinguished by the name *St. John's group*, or *Acadian*, and embraces the slates at Braintree, Mass. It is supposed to lie below the *Georgia slates* of Vermont, containing Olenellus, and those to be below the "red sandrock," which is the proper *Potsdam* horizon of the east. The Potsdam horizon of the Wisconsin geologists lies still higher in the primordial, and is allied, in its paleontology, to the Calciferous sandrock. It has but recently been known to exist in eastern New York. Mr.

**American Journal of Science.* (2) xvii, 237.

porphyries of the *Cupriferous series* of the north shore of lake C. D. Walcott has named a number of fossils from it in the Twenty-third Regents' Report on the New York State Cabinet, collected near Saratoga.* These are from a dolomitic limestone which he considers the *Calciferous*, and, indeed, probably is the same that has been so known. Thus it becomes necessary either to abandon the Calciferous in the East as a paleontological division, extending the *Potsdam* horizon upward so as to cover it, or to abandon the claim that the Potsdam, so called by the Wisconsin geologists, as exposed along the Mississippi river, is the true Potsdam. This dilemma was pointed out in 1872, by the writer, in the first report of the survey, and again enforced in the tenth, after this discovery of Mr. Walcott had been made known.

Further, the extension of the primordial zone so much further downward in the Northwest, on the evidence of discovered primordial fossils in the red quartzyte, allows ample room for the existence of the true *Potsdam* of New York as well as of the *Georgia slate* group, between the *St. Croix* sandstone and the pipestone beds. In several deep wells that have been drilled in central and southeastern Minnesota there has been found, beneath the St. Croix sandstone, without exception, a great thickness of red and green shales, associated with some red sandstone. This sometimes has reached the thickness of nearly four hundred feet, and is succeeded below by a hard, red quartzyte or brownish red rock, fine grained or granular, which has been uniformly supposed to be the equivalent of the red quartzytes that outcrop at New Ulm and in Pipestone county. These red shales perhaps represent the *Georgia slates;* and the red sandstone connected with them, apparently expanding toward lake Superior so as to become the red sandstones there called *Potsdam* by the Wisconsin geologists (and perhaps also the Cupriferous series) may be parallelized with the true Potsdam of New York.

Intimately connected with these red quartzytes in Wisconsin are red gneisses† and felsytes, or felsitic porphyries, the quartzytes being below these rocks, and all presenting evidences of sedimentary origin (*Geol. of Wis.*, vol. ii. p. 514). These are therefore brought within the primordial zone, and can be considered as being near analogues of the red felsytes and quartz-

* Science, III, 136.

† Some of the rock at New Ulm is also a red gneiss, of fine grain.

Superior, and, if of sedimentary origin, modified portions of the *Georgia slates*, the *St. John's group* being represented by the gneissic red quartzytes of Pigeon Point and Waswaugoning Bay, at the very base of the *Cupriferous series*.

X.

THE NEW ORLEANS INDUSTRIAL AND COTTON CENTENNIAL EXPOSITION.

The exhibit of the survey at the *New Orleans Industrial and Cotton Centennial Exposition* is quite extensive. It embraces the following parts:

683 specimens of Minnesota crystalline rock samples.
specimens of other Minnesota rock samples.
56 specimens of Minnesota minerals.*
304 specimens of Minnesota fossils.*
57 specimens of Minnesota mammals (stuffed).
specimens of Minnesota birds (stuffed).
28 specimens of Minnesota soils.
49 specimens of Minnesota plants.
58 specimens of Minnesota woods.
specimens of eggs of Minnesota birds.
21 specimens of Minnesota building stones.
specimens of Minnesota (Red Wing) pottery.
126 specimens of manufactured articles of catlinite.
21 miscellaneous specimens of Minnesota rocks, slates, granites, iron ores, clays, etc.
20 maps of the state, of the scale of ten miles to the inch, designed to show the physical features, geology, distribution of timber, and the main features of climate and soil.
66 meteorites from all parts of the world.
16 bound volumes representing the stated publications of the survey.

The detailed list and description of these articles will be reported to the *Minnesota state board of collective exhibits*, and will be communicated through the state commissioner, Mr. Oliver Gibbs, Jr., to the governor.

* This number expresses the register entries; the specimens were two or three times as many.

XI.

REPORT ON THE MUSEUM FOR 1884.

The following list of additions does not include zoological specimens received since the last report, the number of which is quite large. Many of these are on exhibition at New Orleans, consisting of birds and mammals.

The specimens of plants received by the survey, in response mainly to the circular issued in the year 1876, are specified in the following enumeration. An important donation has been received from the United States department of agriculture, Washington, consisting of 1,194 species of American and foreign plants.

The condition of the museum at present is chaotic, owing to the removal of a large quantity of the specimens to New Orleans. It is expected these will be returned early in June, and they will then be restored to their places in the cases.

Collections of plants in the possession of the Geological and Natural History Survey of Minnesota, April 1, 1885.

1. *U. S. Department of Agriculture*, Washington, D. C. A collection of 638 species of American and 556 species of foreign plants. Presented 1884.

1194 species.

2. *John B. Leiberg.* A collection of Minnesota plants from Blue Earth county. Presented, April, 1883.

78 species.

3. *John B. Leiberg.* A collection of western plants from Dakota and Montana. Presented, August, 1883.

114 species.

4. *Dr. W. E. Leonard.* A collection of Minnesota plants, by the late J. C. Kassube. Presented by Dr. W. E. Leonard, of Minneapolis, Minn., 1884.

440 species.

5. *C. L. Herrick.* Minnesota plants, collected on the Geological and Natural History Survey at various times.

529 species.

6. *B. Juni.* Plants of the north shore of lake Superior. Collected on the Geological and Natural History Survey. August–September, 1878.

175 species.

7. *T. S. Roberts.* Plants of the north shore of lake Superior. Collected on the Geological and Natural History Survey, July–September, 1879.

137 species.

8. *Dr. W. E. Leonard.* Minnesota plants. Collected on the Geological and Natural History Survey, 1875-6.

64 species.

9. *Prof. N. H. Winchell.* Minnesota plants. Collected at various times.

75 species.

10. *H. V. Winchell.* Minnesota plants. Collected at various times.

150 species.

11. "*Ex herbario horti Petropolitani.*" A collection of foreign plants. Presented.

155 species.

12. *Miss Macfarlane.* A collection of plants from southern Labrador. Presented.

25 species.

13. *F. W. Anderson.* A collection of plants from Montana. Presented, February, 1885.

72 species.

14. Through Mr. Warren Upham plants have been presented from the following persons:

Dr. Geo. Vasey, Washington, D. C., 7 species of Aristida and 14 of Panicum.

Prof. C. J. Gedge, Moorhead, Minn.

18 species.

Rev. J. Scott, West Emerson, Manitoba.

24 species.

Dr. J. H. Sandberg, Red Wing, Minn.

5 species.

Mr. R. J. Cratty. Six species of rare plants from Emmett county, Iowa.

In all 3283 species, including duplicates.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5360	1881.	Geol. and Nat. Hist. Survey	Magnesian limestone (light)	1	Kasota	Shakopee	N. H. Winchell.
5361	1884.	" "	Drift limestone	5	Burnsville, sec. 25, Dak. co.	Drift	" "
5362	"	" "	Sandstone	1	Near Ft. Snelling, Dak. co.	St. Peter	" "
5363	"	" "	"North River bluestone"	2	Rondout, N. Y.		Presented by N. H. Winchell.
5364	"	" "	Red pipestone	1	Near Rice Lake, Barren co., Wis.	Potsdam	Presented N. H. Winchell. (Layer six feet thick.)
5365	"	" "	Purple pipestone	1	" "	"	Presented N. H. Winchell. (3 feet thick, underlying No. 5364.)
5366	"	" "	Quartzyte	3	" "	"	Presented by N. H. Winchell. (Overlying the pipestone—last two numbers.)
5367	"	" "	Pipestone	7	Near Luverne, Rock co.	"	Presented by J. C. Constable. At the base of "The Mound."
5393	Nov., 1883.	" "	Sequoia Winchellii, Lesq., Lesquereux' No. 115	1	Cottonwood River, S. of New Ulm	Dakota	N. H. Winchell. Compare No. 115.
5394	"	" "	Populus elegans, Lesq., Lesquereux' No. 5155 c	1	" "	"	N. H. Winchell. Compare No. 5155.
5395	"	" "	Populus cyclophylla? Heer, Lesquereux' No. 5155 K. P. G	3	" "	"	N. H. Winchell. Compare No. 5155.
5396	"	" "	Populus litigiosa, Heer, Lesquereux' No. 5155 A. A. M	3	" "	"	N. H. Winchell. Compare No. 5155.
5397	"	" "	Populus lancastriensis, Lesq., Lesquereux' No. 5155 D	1	" "	"	N. H. Winchell. Compare No. 5155.
5398	"	" "	Platanus species, Lesquereux' No. 5155 S	1	" "	"	N. H. Winchell. Compare No. 5155.
5399	"	" "	Ficus austiniana, sp. nov., Lesquereux' Nos. 3808 and 5163	2	" "	"	N. H. Winchell. Compare Nos. 3808 and 5163.
5400	"	" "	Laurus plutonia, Heer., Lesquereux' No. 5157 C	1	" "	"	N. H. Winchell. Compare No. 5157.
5401	"	" "	Cinnamomum Scheuchzeri? Heer., Lesquereux' No. 5155 I	1	" "	"	N. H. Winchell. Compare No. 5155.

5402	Nov., 1883.	Geol. and Nat. Hist. Survey	Andromeda Parlatorii, Heer., Lesquereux' No. 5157 A	1	" "	"	N. H. Winchell. Compare No. 5157.
5403	"	" "	Cissus Browniana, sp. nov., Lesquereux' No. 5156	1	" "	"	N. H. Winchell. Compare No. 5156.
5404	"	" "	Magnolia alternans, Heer., Lesquereux' No. 5155 B	1	" "	"	N. H. Winchell. Compare No. 5155.
5405	"	" "	Dewalguea primordialis, sp. nov., Lesquereux' No. 5158	1	" "	"	N. H. Winchell. Compare No. 5158.
5406	"	" "	Protophyllum crednirioides, Lesq., Lesquereux' No. 5155 P	1	" "	"	N. H. Winchell. Compare No. 5155.
5407	"	" "	Sapindus Morrisoni, Lesq., Lesquereux' Nos. 3808 and 3912	2	" "	"	N. H. Winchell. Compare Nos. 3808 and 3912.
5408	June, 1884.	" "	Marl	Indif.	Johnson's Lake, Minneapolis	Drift	N. H. Winchell.
5409	July, 1884.	Mr. Davis	Quartzyte (pinkish white)	1	Garden Valley, Jackson co., Wis	Potsdam?	Presented by M. Davis, of Merillan.
5410	"	Presented	Calamine	1	Endy Mine, Friedensville, Lehigh co., Pa.		From J. Eyerman.
5411	"	"	Sphalerite (gray)	4	" "		" "
5412	"	"	Greenockite	1	" "		" "
5413	"	"	Azurite	1	Cornwall, Lebanon co. Pa		" "
5414	"	"	Malachite	1	Ecton Mine, Shannonville, Pa		" "
5415	"	"	Pyromorphite	1	Wheatley Mine, Phœnixville, Pa		" "
5416	"	"	Galenite	1	" "		" "
5417	"	"	Sphalerite (brown)	2	" "		" "
5418	"	"	Hydrodolomite and chromite	1	Woods' Pit, Lancaster co., Pa		" "
5419	"	"	Hydromagnesite and chromite	1	" "		" "
5420	"	"	Magnesite	1	" "		" "
5421	"	"	Hydrocuprite	1	Cornwall, Lebanon co. Pa		" "
5422	"	"	Limonite ("pipe ore")	1	Wharton Iron Mine, lower Saucon Twp., Northampton co. Pa.		" "
5423	"	"	" (geode)	1	" "		" "
5424	"	"	"	1	" "		" "
5425	"	"	Hematite	1	" "		" "
5426	"	"	" (fossiliferous)	1	Center co., Pa		" "
5427	"	"	" (specular)	1	Isle of Elba		" "
5428	"	"	Tourmaline and quartz	3	Easton, Northampton co., Pa		" "
5429	"	"	Biotite and talc	1	" "		" "
5430	"	"	Epidote and bl. hornblende	1	Frankford, Philadelphia co., Pa		" "
5431	"	"	Turgite	1	Easton, Nthmptn co., Pa.		" "

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5432	July, 1884.	Presented	Malachite	2	Arlington, N. J.		From J. Eyerman.
5433	"	"	Quartz (rose colored)	1	Southford, Conn.		" "
5434	"	"	Franklinite, polydelphite, rhodonite, and willemite	1	Franklin, Sussex co., New Jersey		" "
5435	"	"	Wernerite	1	Bolton, Mass.		" "
5436	"	"	Garnet (polydelphite)	1	Franklin, N. J.		" "
5437	"	"	Zircon	1	Renfrew, Ontario, Can.		" "
5438	"	"	Calcite	1	" "		" "
5439	"	"	Fluorite	1	Rosiclare, Ill.		" "
5440	"	"	Iron ore	1	Algiers, Africa		" "
5441	"	"	Amethystine quartz	1	Clayton, Raybun co., Georgia		" "
5442	"	"	Magnetite	1	Verona, N. J.		" "
5443	"	"	Hematite	1	Chester co. lead mines, Phœnixville, Pa.		" "
5444	"	"	Magnetite	1	Essex co., N. J.		" "
5445	"	"	Amphibole (tremolite)	1	Pennsylvania		" "
5446	"	"	Psilomelane	1	Wharton Mine, Northampton co., Pa.		" "
5447	"	"	Franklinite and zincite	2	Franklin, Sussex co., N. J.		" "
5448	"	Geol. and Nat. Hist. Survey	Sandstone (rusty, cemented)	1	N'r Ft. Snelling, Dak. co.	St. Peter	N. H. Winchell.
5449	"	Presented	Building stone block	1	Nininger	St. Law	1 foot by 1 foot 6 inches.
5450	"	"	Oolyte	34	Stillwater		From A. D. Roe.
5451	Aug., 1884.	Geol. and Nat. Hist. Survey	Drillings from the Humboldt salt well — lacustrine clay with lime concretions	1 bottle.	Humboldt, Minn.		N. H. Winchell. (4 to 16 feet.)
5452	"	" "	The same, but darker colored	"	" "		" " (16 to 140 feet.)
5453	"	" "	Pebbly blue till. (Saltwater at 165 feet)	"	" "		" " (140 to 170 ft.)
5454	"	" "	Drift gravel and sand. (More salt water.)	"	" "		" " (170 to 180 ft.)
5455	"	" "	Dolomitic limestone (buff)	"	" "		" " (180 to 190 ft.)
5456	"	" "	Finer drillings of the same	"	" "		" " (190 to 300 ft.)
5457	"	" "	The same, slightly pinkish	"	" "		" " (300 to 400 ft.)

5458	"	" "	Reddish shale or limerock. (Washed drillings of this are mainly limerock.)	"	" "		" " (400 to 475 ft.)
5459	"	" "	Reddish sand of rounded quartz grains	"	" "		" " (475 to 500 ft.)
5460	"	" "	White sand of rounded quartz grains. (Salt water flow increased)	"	" "		" " (500 to 532 ft.)
5461	"	" "	Faintly reddish quartz grains	"	" "		" " (532 to 546 ft.)
5462	"	" "	"Soapstone" shale, red and green	"	" "		" " (546 to 550 ft.)
5463	"	" "	The same, gray in general color	"	" "		" " (550 to 556 ft.)
5464	"	" "	The same, reddish brown	"	" "		" " (556 to 560 ft.)
5465	"	" "	The same, with grains of a white air-slaking mineral, which effervesces in No. 5	"	" "		" " (560 to 571 ft.)
5466	"	" "	The same, but lighter colored	"	" "		" " (571 to 592 ft.)
5467	"	" "	Greenish gray shale, the same as No. 13	"	" "		" " (592 to 610 ft.)
5468	"	" "	Greenish gray shale, containing bits of grayish quartzyte, that feebly effervesces in H. C. L.	"	" "		" " (610 to 635 ft.)
5469	"	" "	The same unwashed	"	" "		" " (635 to 638 ft.)
5470	"	" "	Greenish gray, foliated, micaceous quartz-schist, washed	"	" "		" " (638 to 639 ft.)
5471	"	" "	Quartz, feldspar, and mica, washed	"	" "		" " (639 to 641 ft.)
5472	"	" "	Quartz, feldspar, and mica, washed	"	" "		" " (641 to 644 ft.)
5546	1880.	" "	Columnaria alveolata (Gold)	1	Near St. Charles	Trenton	" "
5549	"	" "	Orthis whitfeeldi (Winch)	15	Spring Valley, l. m. e.	"	" "
5555	1884.	" "	Paradoxides barberi (Winch)	1	Pipestone county	Acadian	From A. W. Barber.
5556	"	" "	Chlorastrolites	Indif.	Isle Royal	Cuprif.	Purchased. (In two vials.)
5557	"	" "	Thomsonites	"	Grand Marais	"	" (In a vial.)
5558	"	" "	Hematite	9	Vermilion mines	Archa.	N. H. Winchell.
5559	Nov., 1884.	" "	Slabs of catlinite, showing forms like small Lingulæ	Ind.	Pipestone quarry	Potsdam	" "
5560	1883.	" "	Clay pebbles	"	Princeton	Drift	U. I. Small.
5561	1883.	N. H. Winchell	Trap rock	3	Orange Mt., N. J.	Archa	Presented by N. H. Winchell.
5562	"	" "	Felsyte	3	High Rock, Lynn, Mass.		" "
5563	"	Geol. and Nat. Hist. Survey	Silicified fossils, from the Cret. conglomerate	31	Red Jacket Bridge, nr. Mankato		N. H. Winchell.
5564	"	" "	Series showing passage from magnesian schist to hematite	4	Vermilion iron mines	Archa	"
5565	"	Geo. C. Stone	Hematite, from Stuntz mine	1	" "	"	Presented by Geo. C. Stone.
5566	"	" "	" " Ely mine	1	" "	"	" "
5567	"	" "	" " Stone mine	1	" "	"	" "
5568	"	" "	" " Lee mine	1	" "	"	" "
5569	"	" "	" " Tower mine	1	" "	"	" "
5570	"	" "	" " Breitung mine	1	" "	"	" "
5571	"	" "	" " Armstrong mine	1	" "	"	" "
5572	"	D. S. Martin	Lignite	4	Disco Island, Greenland		" D. S. Martin.
5573	"	" "	" mainly organic	2	Bahia, Brazil		" " (Used for making gas New York.
5574	"	Geo. F. Kunz	Native antimony	1	Prince William, York co., New Brunswick		Presented by Geo. F. Kunz.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.—(Continued.)

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5575	1884.	A. A. Julien	Sonorous sand		Atlantic shore		Presented by A. A. Julien.
5576	"	B. Juni	Wood from a well 116 feet deep	Ind.	New Ulm, Minn	Drift	" B. Juni.
5587	Aug., 1884.	B. W. Thomas	Sporangites Huronensis, Daw	"	Chicago, Ill	Devon	" B. W. Thomas, Chicago, boulder clay.
5588	Dec., 1884.	A. W. Barber	Crocidolite	1	South Africa		Presented by A. W. Barber.
5589	June, 1884.	Prof. W. F. Phelps	"White iron" and arsenical sulphuretes, carrying gold	1	Bear Gulch, Mont		" Prof. W. F. Phelps.
5590	"	" "	Lava from H. O. W. copper mine	1	Black Hills, Dak		" "
5591	"	" "	Gold bearing quartz, carrying iron pyrites	1	Bear Gulch, Mont		" "
5592	"	" "	Silver ore (sulphide)	1	Vienna Mine, Idaho		" "
5593	"	" "	Silver sulphide	1	" "		" "
5594	"	" "	Argentiferous galena	1	Black Hills, Dak		" "
5595	"	" "	Galena and silver ore	2	Near Maiden, Mont		" "
5596	"	" "	Galena and silver	1	Concord mine, Maine		" "
5597	"	" "	Argentiferous galena	1	Montana		" "
5598	"	" "	Copper bearing quartz	1	Belt Range, Mont		" "
5599	"	" "	Oxide copper	3	Black Hills, near Sheridan, Dak	Cup	" "
5600	"	" "	"	1	Black Hills, Dak	"	" "
5601	"	" "	Carbonate copper in quartz	2	Belt Mts., Mont., near Livingston	"	" "
5602	"	" "	Carbonate copper	4	Black Hills, n'r Sheridan	"	" "
5603	"	" "	Green carbonate and oxide of copper	2	Black Hills, Dak	"	" "
5604	"	" "	Carbonate of copper from shaft 25 feet	11	" "	"	" "
5605	"	" "	" " from open cut	8	" "	"	" "
5606	"	" "		1	Belt Mts., Mont		" "
5607	Jan., 1884.	Presented	White sandstone	2	Lansing, Iowa		" by J. M. Turner.
5608	1884.	"	Group of quartz crystals	1	Ozark Mts.		" Hon. Richard Chute, obtained at Hot Springs.
5609	Sept., 1883.	Geol. and Nat. Hist. Survey	Darkish gray, shaly, siliceous, and probably dolomitic. First well	1 bottle.	St. Paul, Minn		W. Upham (500–525–582 feet.)
5610	"	" "	The same. First well	"	" "		" No. 2 (500–525–582 ft).

5611	"	"	"	" "	"	"	"	Drillings from the Harvester Works Well.	"	(582–592 feet.)
5612	"	"	"	" "	"	"	"		"	(592–602.)
5613	"	"	"	" "	"	"	"		"	(602–612.)
5614	"	"	"	" "	"	"	"		"	(612–626.)
5615	"	"	"	Dark, sandy, and clay loam. Second well	"	"	"		"	(1–10 feet.)
5616	"	"	"	Gray sand and fine gravel. Second well	"	"	"		"	(10–20.)
5617	"	"	"	Same, with pebbles up to 1½ in. diam. Second well	"	"	"		"	(20–30.)
5618	"	"	"	Yellowish, coarse sand. Second well	"	"	"		"	(30–40.)
5619	"	"	"	Yellowish sand and gravel. Second well	"	"	"		"	(40–50.)
5620	"	"	"	The same (fine gravel). Second well	"	"	"		"	(50–60.)
5621	"	"	"	Light gray sand and fine gravel. Sc'nd well	"	"	"		"	(60–70.)
5622	"	"	"	The same. Second well	"	"	"		"	(70–80.)
5623	"	"	"	The same. Second well	"	"	"		"	(80–90)
5624	"	"	"	Light gray, fine sand and pebbles, 1½ in. diam. Second well	"	"	"		"	(90–100.)
5625	"	"	"	The same, with pebbles ¾ in. Sc'nd well	"	"	"		"	(100–110.)
5626	"	"	"	Light gray sand and gravel. Second well	"	"	"		"	(110–120.)
5627	"	"	"	The same. Second well	"	"	"		"	(120–130.)
5628	"	"	"	The same (gravel fine). Second well	"	"	"		"	(130–140.)
5629	"	"	"	Light, reddish gray sand, with pebbles. Second well	"	"	"		"	(140–150.)
5630	"	"	"	The same, with pebbles 2 in. in diam. Second well	"	"	"		"	(150–160.)
5631	"	"	"	The same, with pebbles up to 1½ in. Second well	"	"	"		"	(160–170.)
5632	"	"	"	Light gray sand, with pebbles 1 in. in diameter. Second well	"	"	"		"	(170–180.)
5633	"	"	"	Coarse gravel. Second well	"	"	"		"	(180–190.)
5634	"	"	"	Similar to last, but with more sand. Second well	"	"	"		"	(190–200.)
5635	"	"	"	Same, mostly finer. Second well	"	"	"		"	(200–210.)
5636	"	"	"	Same, with pebbles up to 2 in. diam. Second well	"	"	"		"	(210–220.)
5637	"	"	"	Yellowish sand, with few gravel stones. Second well	"	"	"		"	(220–230.)
5638	"	"	"	Fragments of a buff magnesian limestone, with some sand and gravel. Scnd well	"	"	"		"	(230–240.)
5639	"	"	"	Limestone, light yellowish. Second well	"	"	"		"	(240–250.)
5640	"	"	"	Limestone, light buff. Second well	"	"	"		"	(250–260.)
5641	"	"	"	Similar to last. Second well	"	"	"		"	(260–270.)
5642	"	"	"	Light buff magnesian limestone. Sc'nd well	"	"	"		"	(270–280.)
5643	"	"	"	Yellowish buff magnesian limestone. Second well	"	"	"		"	(280–290.)
5644	"	"	"	Yellowish powder, with fragments of magnesian limestone. Second well	"	"	"		"	(290–300.)
5645	"	"	"	Mostly fine, light gray powder, with fragments of magnesian limestone. 2d well	"	"	"		"	(350–360).

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.—(Continued.)

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5646	Sept., 1883.	Geol. and Nat. Hist. Survey	Sandstone, light yellowish, with dolomitic powder. Second well	1 bottle.	St. Paul, Minn	Drillings from the Harvester Works Well.	W. Upham (360–370.)
5647	"	" "	Limestone, light yellowish buff. Se'nd well	"	" "		" (370–380.)
5648	"	" "	Sandstone, light gray. Second well	"	" "		" (380–390.)
5649	"	" "	Same, with pieces of coal, metallic iron, and furnace slag. Second well	"	" "		" (390–400.)
5650	"	" "	Same, with coal and battered scales of metallic iron. Second well	"	" "		" (400–410.)
5651	"	" "	The same as last. Second well	"	" "		" (410–420.)
5652	"	" "	Same, but finer and white, with some pyrite and few iron scales. Second well	"	" "		" (420–430.)
5653	"	" "	Same, with slight traces of coal and iron scales. Second well	"	" "		" (430–440.)
5654	"	" "	Same as last. Second well	"	" "		" (440–450.)
5655	"	" "	Sandstone, fine, water-worn. Second well	"	" "		" (450–460.)
5656	"	" "	" coarse, yellowish gray. 2d well	"	" "		" (460–470.)
5657	"	" "	" very fine, light yellow. 2d well	"	" "		" (470–480.)
5658	"	" "	Sandstone, very fine, light, leaden gray. Second well	"	" "		" (480–490.)
5659	"	" "	Sandstone, very fine, light, dusky gray. Second well	"	" "		" (490–500.)
5660	"	" "	Sandrock, gray, compact, and hard, probably dolomitic. Second well	1	" "		" 6 in. of core at 555 ft.
5661	"	" "	Same as the preceding. Second well	3	" "		" 18 in. of core at 578 ft.
5662	"	" "	Sandrock, light, yellowish buff. Se'nd well.	2	" "		" 12 in. of core at 590 ft.
5663	"	" "	Similar to the last. Second well	9	" "		" 11 in. of core at 626 ft.
5664	"	" "	Sandrock, hard and compact, with layers of dark green sand. Second well	17	" "		" cores f'm 650 to 660 ft.
5665	"	" "	———. Second well	28	" "		" cores, depth not k'wn.
5666	1884.	Presented	Cretaceous leaves	13	Mankato, Minn	Cret.	From Mr. S. F. Alberger.
5699	"	By purchase	Felsyte	1	Minneapolis, Minn	Drift	" W. Howling.
5700	"	"	Asaphus megistos	1	Butler co., O		Prof. C. W. Hall. Cast.
5702	Oct., 1884.	By exchange	Lingula melie, Hall	1	Licking co., O	Cuyahoga sh.	From Prof. C. L. Herrick.

5703	"	" "	Lycopodites vanuxemi, Dow	1	Ithaca, N. Y.	Chemung	" "	
5704	"	" "	Streptelasma corniculum, Hall	1	Dayton, O.	Tr'n & Hud.	" "	
5705	"	" "	Pentamerus oblongus, Sowerby	2	Springfield, Clark co.	Niagara	" "	
5706	"	" "	Strophomena alternata, Conr.	8	Cincinnati, O.		" "	
5707	"	" "	Leptæna sericea	2	Dayton, O.		" "	
5708	"	" "	Allorisma Winchelli, Meek	2	Rushville, O.		" "	
5709	"	" "	Sanguinolites obliquus	2	"		" "	
5710	"	" "	Sperifera mucronata (?)	1	Ithaca, N. Y.	Chemung	" "	
5711	"	" "	Rhynchonella dentata, Hall	2	Dayton, O.	Cincinnati.	" "	
5712	"	" "	" increbescens	2	"	"	" "	Lebanon beds.
5713	"	" "	" "	8	Cincinnati, O.		" "	
5714	"	" "	Orthis biforata	2	"		" "	
5715	"	" "	" occidentalis, Hall (?)	2	"		" "	
5716	"	" "	Streptelasma corniculum, Hall	1	"		" "	
5717	"	" "	Grammysia ventricosa, Meek	1	Rushville, O.		" "	
5719	"	Presented	Endoceras proteiforme, Hall	1	Warren co., O.		From Prof. C. W. Hall.	
5720	"	"	Orthis acutilirata, Conr.	8	Butler co., O.		" "	
5721	"	"	Rhynchonella capax, Conr.	8	"		" "	
5722	"	"	Zygospira cincinnatensis	6	"		" "	
5723	1884.	Geol. and Nat. Hist. Survey	Rusted stone	1	Minneapolis, Minn.		N. H. Winchell.	(At 135 feet.)
5724	"	" "	Quartzose sandstone, composed of rounded grains of pure quartz	Ind.	" "	Drillings from the Lakewood Cemetery Well.	"	(256–276 feet.)
5725	"	" "	The same	"	" "		"	(276–296 feet.)
5726	"	" "	The same	1 bottle.	" "		"	(At 300 feet.)
5727	"	" "	The same	"	" "		"	(At 314 feet.)
5728	"	" "	Dolomitic rock (washed)	"	" "		"	(318–320 feet.)
5729	"	" "	Sand	"	" "		"	(At 320 feet.)
5730	"	" "	White sand	"	" "		"	(At 325 feet.)
5731	"	" "	Slightly red, fine grained, dolomitic rock	Indif.	" "		"	(360–403 feet.)
5732	"	" "	The same, with some mixture of the next (No. 5733)	"	" "		"	(403–416 feet.)
5733	"	" "	Translucent rounded grains of quartz	"	" "		"	(416–424 feet.)
5734	"	" "	The same	"	" "		"	(424–434 feet.)
5735	"	" "	White chert, coated with dolomitic pyrites.	"	" "		"	
5736	"	" "	White quartz sand, rounded	"	" "		"	(434–481 feet.)
5737	"	" "	The same, with traces of light, green shale.	"	" "		"	(481–504.)
5738	"	" "	White quartz sand, rounded, with some green shale	"	" "		"	(504–558.)
5739	"	" "	White sand and green sand	"	" "		"	(558–607.)
5740	"	" "	White sand	"	" "		"	(694–704.)
5741	"	" "	Mainly white sand	"	" "		"	(763–773.)
5742	"	" "	Green clay or shale, non-effervescing, very fine grained	"	" "		"	(780–844.)
5743	"	" "	White sand, with a faint, yellowish tint	"	" "		"	(935–960.)
5744	"	" "	Siliceous sand, with a faint, pinkish tint, rather fine	"	" "		"	(1005–1010.)

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.—(Continued.)

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
5745	1884.	Geol. and Nat. Hist. Survey	Siliceous sand, with a deeper pinkish tint and coarser grain	Indif.	Minneapolis, Minn.	Drillings from Lakewood Cemetery Well.	N. H. Winchell. (1010–1050.)
5746	"	" "	The same, but of a lighter color	"	" "		" (1060–1070.)
5747	"	" "	The same, but cemented, when dry, with ground up reddish shale	"	" "		" (1105–1120.)
5748	"	" "	Compact red clay or shale	"	" "		" (1123–1160.)
5749	"	" "	Sand shale of a reddish color	"	" "		" (bet. 1123–1167)
5750	"	" "	Red shale, mottled with light green	4	" "		" (bet. 1123–1167)
5751	"	" "	Reddish brown shale	Indif.	" "		" (1167–1235.)
5752	"	" "	The same	"	" "		" (1235–1260.)
5753	"	" "	The same	"	" "		" (1260–1365.)
5754	"	" "	The same	"	" "		" (At 1400 feet.)
5755	March, 1885.	" "	Gray, tough cryptocrystalline, similar to survey No. 469 or 478	"	" "		" (At 1860 feet.)

Archæological specimens registered in the General Museum in 1884.

112. Flints (three) from about lake Minnewaska, Minn. Presented by Dan. F. Bartke, of Glennwood, Minn., March 14, 1884.

113. One piece of obsidian from lake Minnewoska. Presented by Dan. F. Bartke, of Glennwood, Minn., March 14, 1884.

114. Bit of red substance from stratum, Little Falls, Minn. Presented November 10, 1882, by Frances E. Babbitt.

115. One piece of sonorous *quartz* from stratum, Little Falls, Minn. (they jingle with other *quartz*-like metal). Presented November 10, 1882, by Frances E. Babbitt.

116. Chipped implement (one), from river gravels at the ferry, Little Falls, Minn. Presented November 10, 1882, by Frances E. Babbitt.

117. Piece of nicked *quartz*, perhaps for cutting tendons, etc., from stratum, Little Falls, Minn. Presented November 10, 1882, by Frances E. Babbitt.

118. Piece of a bone. Little Falls, Minn. Presented, November 10, 1882, by Frances E. Babbitt.

119. A small dark chert arrow point, one and a half inches long, notched base. From Battle Creek, Mich. Presented by Mrs. C. H. Crosby, 1883.

120. Arrow point (one), light chert, three and a quarter inches long, notched base. From Battle Creek, Mich. Presented by Mrs. C. H. Crosby, 1883.

121. Gray flint implement (one), four and a half inches long, rounded base. From Battle Creek, Mich. Presented by Mrs. C. H. Crosby, 1883.

122. Stone hammer (one). Sample of those now in use among the Cheyenne Indians, near the Black Hills. Presented by the Rev. L. J. Hauge, Mankato, 1883.

123. Spear head (one), dark chert, four and three-quarter inches long, pointed at both ends. From section 30, township 45, range 28, west of Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

124. Specimens of pottery (forty-five pieces), from Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

125. Piece of flint (one) from Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

126. Implement of brown chert (one), from Mille Lacs Minn. Presented January 5, 1884, by O. E. Garrison.

127. Stone implement (one), from Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

128. Specimen of tattooing taken from the arm of a cadaver. Presented by Dr. Arthur Eastman.

129. Stone hammer (one), from Illinois. By purchase from Wm. Howling, 1884.

130. Stone hammers (two), from Long Lake, Minnesota. By purchase from Wm. Howling, 1884.

List of books added to the Library of the Geological and Natural History Survey since the publication of the list in the report of 1880.

Proceedings of the Academy of Natural Sciences, of Philadelphia. Parts I and II, January to October, 1879. Purchased.

Proceedings of the Davenport Academy of Natural Sciences. Volume III, Parts II and III, 1879-81. From the Academy.

Transactions of the Edinburgh Geological Society. Volume IV, Part II, 1881-82. Purchased.

Bulletin of the Buffalo Society of Natural Sciences. Volumes I, II, III and IV. Complete. From the Society.

The American Antiquarian and Oriental Journal. Volume IV, No. 1, October, 1881, and No. 4, October, 1882. Volume V, complete. Volume VI, Nos. 1, 3, 4 and 6, 1884. Volume VII, Nos. 1 and 3, January and March, 1885. From the Editor.

Bulletin of the United States Geological Survey. No. 1, 1883. From the Survey.

United States Geological Survey. Mineral resources of the United States. By Albert Williams. From the Survey.

Smithsonian reports for 1863, 1870, 1873, 1875, 1878, 1879, 1881. From the Smithsonian Institution.

Transactions of the Academy of Science, of St. Louis. Volume. IV, Nos. 2 and 3. From the Academy.

Memoirs of the Peabody Academy of Science. Volume I, Salem, Mass. From the Academy.

Report of the Geological Survey of Ohio. Volume IV, Part I. Zoology. From Prof. E. Orton.

Geological Survey of Minnesota. Reports I to VIII, inclusive, 1872-9. One volume. From Mrs. C. M. Terry.

United States Coast and Geodetic Survey. Reports for 1878, 1879 and 1880. From the United States Coast Survey.

United States Geological Survey. Second annual report—1880-81. From the Survey.

Monographs of the United States Geological Survey. Volume II. From the Survey.

Tertiary History of the Grand Canon District, with atlas, by Clarence E. Dutton. From the Survey.

Bergens Museum. Nye Alcyonider Gorgonider og Pennotulider tilhorande Norges Fauna. Ved Johan Koren og D. C. Danielson. From the Museum.

American Association for the Advancement of Science. Local committee papers of the Montreal meeting, 1882. From the Minneapolis local committee.

American Association for the Advancement of Science, Local committee papers of the Minneapolis meeting, 1883. From the Philadelphia local committee.

Reports of the State Geologist of Indiana, 1869, 1870, 1871-2, 1873, 1874, 1875, 1876-7-8, 1880, 1881, 1882 and 1883. From John Collett, state geologist.

The Catalogue of the Museum of the Military Service Institution of the United States, 1884. From Lieutenant A. W. Vogdes.

The American Chemical Journal. Volumes I, II, III, IV and V. Nos. 1, 2, 3, 4 and 5 of Volume VI. From Johns Hopkins University.

United States Geological Survey. Geology of the Comstock Lode. Monograph No. 3. By Geo. F. Becker. From the Survey.

United States Geological Survey. Atlas to accompany the Monograph on the geology of the Comstock Lode, and the Washoe District. By Geo. F. Becker. From the United States Geological Survey.

United States Geological Survey. Third annual report, 1881-2. J. W. Powell. From the Survey.

Proceedings of the Colorado Scientific Society. Volume I, 1883-4. From the Society.

Plates and maps in illustration of the first volume of the transactions of the Geological Society, London, 1811. Presented by A. J. Hill, of St. Paul.

Bulletins of the United States Geological Survey, Nos. 2, 3, 4, 5, and 6. From the Survey.

United States Geological Survey, Monograph, Volume IV, Comstock Mining and Miners. By Eliot Lord. From the Survey.

XII.

NOTES ON THE GEOLOGY OF MINNEHAHA COUNTY, DAKOTA.

BY WARREN UPHAM.

Typical Potsdam quartzyte outcrops one mile southeast of Dell Rapids (which is on the Sioux river, some fourteen miles west from the northwest corner of Rock county), dipping about 2° south, 35° west (as referred to the true meridian). *Glacial striæ*, well shown at this place, bear south 25° to 30° east. (This locality, like the mound, is beyond the limits of the ice of the last glacial epoch, and therefore these striæ were formed by the earlier ice-sheet. When that ice-sheet terminated beyond the Missouri river in Nebraska and Kansas, we cannot doubt that the ice current moved nearly from north to south upon all this region midway between the west border of the ice and the driftless, never ice covered, area of Wisconsin and southeastern Minnesota; but the prevailing striation at the mound and the pipestone quarry bearing southwesterly, and of this locality near Dell Rapids bearing southeasterly, demonstrate that during the final melting and recession of that earlier ice-sheet it became in this portion lobed, with different slopes of its surface and different directions of the motion of its ditsinct lobes and their various portions, principally (as I believe) produced by meteorological conditions, nearly as the terminal moraines of the last ice-sheet show that it, in the later glacial epoch, was lobed and had different directions of motion in its different parts upon areas not more than twenty-five miles distant from these localities toward the northeast and northwest. (See plate VI, in the *Ninth annual report*). *Ripple-marks* are occasionally seen on the quartzyte at this outcrop. This rock is here visible in low exposures, extending an eighth of a mile, along a northwardly sloping slight depression excavated by drainage.

Quartzyte also outcrops one mile due east of Dell Rapids, on the east side of the Big Sioux river (commonly called simply "Sioux river"); and again, one and a half miles north of Dell Rapids, on section three, about one and a half miles west of the river. These are its most northern exposures that I heard of in this region. No fossils, no pipestone, and no conglomerate portions, are known in this quartzyte.

Water power. William Van Eps, Dell Rapids (s. ½ of sec. 9); Dell Rapids mills; fall, eleven feet, with right to increase to fourteen. The fall in the Sioux river, at and below Dell Rapids, from Van Eps' pond (which holds the river as back-water to a distance of three miles), to a point one and a half miles south of the junction of the "Dells" channel, or about four miles south of Dell Rapids village, is approximately twenty-five feet. At Mr. Van Eps' present hight of flowage, a dam about three feet high has to be provided to turn the water of this pond in the Sioux river from running into the "Dells" channel; but before the mill dam was built the stage of low water at the bridge at Dell Rapids was about six feet lower than the divide between it and the "Dells." This sketch, figure eight (I have no good map), will serve to give some idea of the relative position of the localities mentioned.

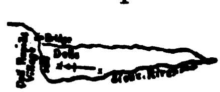


FIG. 8.

"*The Dells.*" The Sioux river, after passing the village of Dell Rapids, first runs westerly a half mile, more or less, and then flows south, inclosed by walls of Potsdam quartzyte. Another rock-walled channel of the same kind, called the "Dells," already several times referred to, extends south from near the bridge in Dell Rapids village. It is thus east of the present course of the Sioux river at its ordinary stage, but a large part of the river flows through this channel at its times of flood. The picturesque rock gorge called the "Dells" extends about one and a half miles in rock, from near the river at Dell Rapids village to the south; and this channel is said to continue across the alluvial bottom-land about one and a half miles further before joining the present channel of the Sioux river. The highest walls of this gorge are within three-quarters of a mile south of Dell Rapids, along which distance they rise vertically on each side 30 to 40 or 50 feet above the still water that fills the bottom of the gorge along a distance of one and a quarter miles, varying in width from three to five rods, and ten to twelve feet deep. The rock here is typical quartzyte, dipping two or three feet in a hundred, or

about one degree, to the south-southwest. This quartzyte is bedded in layers from a few inches to one foot or rarely two feet thick, and is intersected by very numerous vertical or nearly vertical joints, which often divide it into rhomboidal fragments only from three to six inches or a foot long. The surface of the bedding-planes is frequently ripple-marked. No glacial striæ were found here; all the rock surface appears somewhat water-worn. The erosion of this channel has been facilitated by the jointed structure of the rock, and both this and the channel now occupied by the river have probably been eroded by this stream since the ice age.

This quartzyte is mostly very hard and of a reddish gray color, about as at its exposures near New Ulm, in Cottonwood county, and in Pipestone and Rock counties. At the quarry on the east side of the "Dells," near their south end, a mile south of Dell Rapids village, the color of this stone is light gray, slightly tinged toward pink. Rarely it occurs with a quite soft, somewhat friable texture, as was found in a well at Dell Rapids. This rock is seen in frequent low outcrops for about a mile south from the south end of the "Dells," beyond which no rock-outcrops were learned of in the next fifteen miles southward, their next occurrence being at Sioux Falls.

The gorge through which the Sioux river flows, close below Mr. Van Eps' mill, or about a mile southwest from Dell Rapids village, is said to be inclosed by vertical walls of the quartzyte, some fifteen feet high. In this channel three remnants of the rock stand up like bridge piers, having the same hight as the rock on each side. The whole thickness of the Potsdam quartzyte exposed at Dell Rapids is about seventy-five feet; it cannot exceed one hundred feet. Its top here may be one hundred feet above its top at Sioux Falls; this estimate being dependent mainly on another, namely, that the river at Dell Rapids is seventy-five feet above Emerson, Sherman & Co's mill pond at Sioux Falls.

Bottomland from one to two miles wide borders the Sioux river from a point one and a half miles south of Dell Rapids to Sioux Falls. Its hight is about ten feet above the river, by which it has been overflowed three times during the past eleven years. The surface at each side is moderately undulating till, with swells 25 to 40 feet above its depressions, the hight being 50 to 90 feet above the river and the bottomland.

Nils B. Peterson's well; northwest quarter, Section 3, T. 102, R. 49 (nine miles north of Sioux Falls), well, 30 feet; soil, 2; yellow

till, spaded, 5 feet; sand, 3 feet, yielding the only water found; very hard blue till, picked, 21 feet, and extending lower; water a plenty for house and twenty cattle. The till here and generally in this region, contains as large a proportion of gravel and boulders (varying in size from a few inches or one foot to five feet in diameter) as is usually found in the till of southern and western Minnesota.

Pipestone, similar to that of the famous pipestone quarry in Minnesota, is reported as occurring eight miles distant, nearly due west from Mr. Peterson's (therefore about 12 miles northwest from Sioux Falls), or four miles west of New Hope post office, on Skunk creek in the northeast part of T. 102, R. 51. Much of this pipestone is red, other portions are mottled or sometimes nearly cream-colored, as at the Indian pipestone quarry. It has been whittled into pipe bowls and various trinkets. It is hard at the surface, but softer within; and is thought to form a layer four feet or more in thickness, inclosed in the quartzyte. It has been used to build chimneys, where it does not crack and crumble like the quartzyte.

Sioux Falls. The Potsdam quartzyte is next found exposed in low outcrops about two miles west of Sioux Falls, on the broad bottomland of the Sioux river. The valley eroded in the thick sheet of glacial drift by this river below (eastward from) Sioux Falls is about a mile wide and inclosed by bluffs 100 feet or more in hight on its north side, and from 125 to 150 feet (probably nearly 200 feet at three miles east of Sioux Falls) in hight on its south side; these bluffs being steep, with more knolls, buttresses and ravines than usual (as, for example, on the Minnesota river), making a quite picturesque view as seen from a point a mile north of Sioux Falls, looking eastward and southward. This valley is eroded through till, which in some places was seen to be thinly covered by loess, nearly as in southwestern Rock county, and elsewhere, more rarely, by deposits of gravel and sand; the quartzyte of this vicinity is exposed only in the bottom of the valley, and ends in low outcrops about a half mile below (north and northeast of) Sioux Falls.

Mr. William Van Eps, of Sioux Falls (owner of mill at Dell Rapids), reports outcrops of quartzyte (nearly like that at Sioux Falls) on the James river at Rockport in Hanson county and again in the same county seven miles further north (a few miles below Firesteel, a place formerly important but whose glory has de-

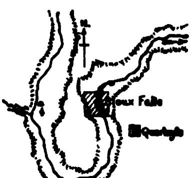


FIG. 9.

parted, eclipsed by Mitchell, three miles distant to the west;) but he thinks this rock has no other exposures on the James river. About fifteen miles east of Mitchell, good quartzyte for quarrying occurs on Pier creek, where it is crossed by the railroad and further north. I think that this quartzyte is reported by Hayden on the east and west Vermilion rivers, in McCook county.

Water power at Sioux Falls. Three dams and mills are here located on the Sioux river:

1. Cascade mills; the upper mill, Emerson, Sherman & Co.: fall or head, 10 feet, flowing the river back about two miles.

2. Queen Bee mill; Sioux Falls Water Power company: head, 56 feet; this mill (built, if I rightly remember, of the quartzyte of this vicinity) is 80x100 feet in dimension, and seven stories (106 feet) high; its walls are 5 feet 4 inches thick at the base, and 2 feet 6 inches at the top.

3. Sioux Falls mills; the lower mill; Webber, Shaw & Watson: head, 14 feet. This lowest mill is not more than a half mile below (north of) the upper mill. There may be five feet of fall lost between these mills; but I think less, or none. The total fall within the city limits (section 16) is said to be 85 feet, which must be nearly or quite correct. If a canal were cut across the base of the river's extensive circuit west of Sioux Falls, excavating about ten feet deep across bottom land for a mile, and some 30 feet in depth for a quarter of a mile through the ridge of drift which extends southward in the west edge of the city, it is said that a fall of about 110 feet in total, or 25 feet more than now, would be obtained.

The rock of Sioux Falls is the typical Potsdam quartzyte, similar in texture, hardness, color (usually reddish-gray), bedding (frequently ripple-marked), and joints, with its outcrops in Nicollet, Cottonwood, Pipestone and Rock counties, and at Dell Rapids. Its dip varies from a half degree to two or three degrees, or a descent varying from one to five feet in a hundred, toward the south and south southwest. Allowing for its dip, the whole thickness of this rock exposed at Sioux Falls is approximately 125 feet; it cannot exceed 150; it nowhere rises much (not more than 20 or 30 feet) above the river at the head of the falls.

Quarries of this stone have been worked in small amount two miles west of Sioux Falls; two miles south of this city on the left (there north) side of the Sioux river, about a half mile from

it, this quarry yielding good stone; and, most of all, in the north part of Sioux Falls corporation. Hayden (in the *Am. Jour. of Sci. and Arts*, for Jan., 1867) says, in describing this formation at Sioux Falls: "About ten feet from the top of the rocks as seen at this locality, is a layer of steatitic material, mottled, gray and cream color, very soft, about 12 inches thick, which is used sometimes for the manufacture of pipes and other Indian ornaments. * * * There are also beds of pudding stone, and the most beautiful illustrations of wave and ripple markings that I have ever observed in my geological explorations."

Glacial striæ. The surface of nearly all the quartzyte exposed at Sioux Falls is so waterworn that its glacial marks have been effaced. Considerable search afforded me only the following observations: About 20 to 25 rods north of the St. Paul & Sioux City (C., St. P., M. & O.) railroad depot, glacial striæ, seen in a half dozen or more places, mostly bear uniformly S. 40° E. (referred to the true meridian, allowing 10° for the needle's variation east of north); but on one surface here, six feet square, situated 10 to 50 feet distant from foregoing glaciated places, are very clear glacial striæ, bearing due east. About a dozen rods northeast from these, striæ were again found, on a smooth surface of rock about ten feet in extent, where they vary in their direction from due south to S. 25° E., these courses being seen on the same surface crossing each other. For the reasons set forth on pages 505 and 549, of vol. 1, final report, it is probable that the striæ bearing south are the oldest, and that the striæ bearing southeasterly and east are records of a progressive deflection here of the ice-current toward the east, by the formation of a lobe in the ice-sheet of this first glacial epoch during its recession. How this would take place will be understood by referring to Plate VI, in the *Ninth annual report*.

Terraces. During the river's excavation of its valley in the thick drift-sheet along the first six miles east of Sioux Falls, a well-marked terrace-plane was formed 60 to 75 feet above the present channel, portions of which remain as follows: One, about two miles long and 20 to 40 rods wide, on the northwest side of the river, 2 to 4 miles northeast from Sioux Falls; another, one and a half miles long and 30 to 60 rods wide, situated on the south side of the river, about 3½ to 5 miles northeast of Sioux Falls; and a third, or perhaps several, seen in the view down the valley within a few miles further southeastward. The first of these terraces, and probably the others, consists of till,

with frequent boulders on its escarpment or face, and in some places on its flat surface above; but mostly this upper surface is thinly covered with fluvial deposits of gravel and sand.

Contour. Lakes and sloughs are rare or absent in all this region; I saw none. The surface is very smooth till, seldom having any covering of loess. The contour of this drift-sheet is quite different from that found upon the regions that were overspread by the last ice-sheet; but closely resembles that of Pipestone and Rock counties. It is characterized by massive swells of varying hight, tending mostly from north to south, or more so than in other directions. The separate swells are usually from 25 to 50 feet above the intervening hollows or depressions; while areas a few miles apart vary sometimes 100 or 150 feet in their average hight. No drift deposits marked by the peculiarly rough and broken contour of our terminal and medial moraines were found in this region.

Palisades post-office, store, and mill are in sections 30 and 31, T. 103, R. 47, at the middle of the south side of section 30, about four miles west from the state line of Minnesota. The "palisades" extend from the dam a half mile southwestward, the Split Rock creek being confined along this distance between vertical walls of the Potsdam quartzyte, 40 to 60 feet high, and from 50 to 150 feet apart. A "rock island" rises like a tower in the middle of this gorge, about 20 rods south of the mill, and 60 feet high, its top being seen with that of the walls at each side, which here attain their greatest altitude.

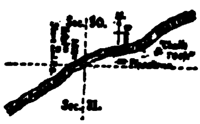


FIGURE 10.

Palisades mill, C. W. Patten; fall, 23 feet; cable to mill, 212 feet; hight from stream below the wheel to the mill, 55 feet. Split Rock creek is said to descend 72 feet in its four miles next above the southwest (lower) end of the Palisades.

The rock here is the typical red Potsdam quartzyte, dipping two to three degrees, or about four to six feet in a hundred, to the south-southwest. This formation embraces in this vicinity two layers, each several feet thick, of compact, fine-grained, red rock, easily cut and polished, closely resembling the catlinite of the Pipestone quarry in Minnesota. The upper one of these layers is seen a quarter of a mile southwest from the mill on the northwest side of the creek, where it has been quarried and is called "slate." Its vertical exposure in the quarry is seven feet, but its base, though probably not much deeper, is not seen.

It lies in sheets from an eighth of an inch to six inches thick, dipping about two degrees S. 30° W. The plane of this bed, prolonged northeastward, passes just above the top of the Palisades. The lower one of the two layers mentioned is called "pipestone," and is scarcely inferior in quality to that of the Indian quarry in Pipestone county. This bed is exposed about five rods south of the dam and some thirty rods east of the mill, where it is seen to have a thickness of at least four feet (it may be as much as seven feet thick) divided in sheets, from a half inch to three or four inches thick. It here dips 6° or 7°, or ten or twelve feet in a hundred, S. 60° W. The unusual steepness of this dip, as compared with the average and nearly uniform dip of the whole formation in this locality, is doubtless due to a local displacement of very small extent; for the floor of quartzyte, on which this pipestone lies, varies in its inclination, within three or four rods away from this bed, to the average dip of about two degrees. At the bottom of the wheel-pit of the mill, 30 rods west from this pipestone quarry, the top of this pipestone layer, having the same fine quality, was excavated to a depth of six inches. The top of this layer in the wheel-pit was 12 or 14 feet lower than its base at its exposure near the dam. This pipestone layer is thus contained in the quartzyte very nearly at the water-line of the creek in the Palisades, being 60 feet, approximately, lower than the similar bed called "slate."

Twenty rods east of the dam at the Palisades, and about 20 to 25 feet above this dam, is an excavation (made to get material for building the dam) into "chalk rock," which is thus exposed with a vertical thickness of four feet (though its base is not seen) and along an extent of about 50 feet, dipping the same as the quartzyte, about two degrees, or some four feet in a hundred, to the south-southwest. It occurs in sheets or layers, which vary from a quarter of an inch to two inches in thickness; and these are much traversed by joints, whereby this rock is divided into a multitude of small rhomboidal pieces, usually a few inches (seldom a foot) long. The upper part of this bed is soft, being scarcely harder than many shale beds, and is whitish, often quite white; it gradually changes below to a pinkish color, and at the same time becomes harder and exhibits fewer joints in its lower portion. In fineness and microscopic homogeneity of texture, it is closely like pipestone (catlinite), which it also probably resembles in chemical character (see Prof. Dodge's analysis, p. 203, *Tenth an. rep.*), not being calcareous, so that its

name, applied by Mr. Patten, is a misnomer. This "chalk-rock" is not seen in contact with the quartzyte or other bedded rocks; but its conformity in dip with the Potsdam formation, so extensively exposed in its immediate vicinity, makes it highly probable that it is a layer inclosed in the quartzyte. It lies in the line of continuation of the closely contiguous "pipestone," and may be only a changed portion of that bed, perhaps having come into its present condition by weathering. If this "chalk-rock" is ground to powder and then wetted, it dries in a hard mass, having about the same hardness as in its original bed.

The following is reported by Mr. C. W. Patten, of the Palisades: About six miles south of this place, or four or five miles above (N. N. E. of), the mouth of Split Rock creek, rock [Cretaceous?] in many respects similar to this "chalk-rock," perhaps harder, all of it whitish as the "chalk" is only at its top, occurs in thicker and more compact layers, and has been considerably used for building. It is cut into dimensions by a common saw; and in weight it is much lighter than the "chalk-rock" of the Palisades, so that a cord of it can be drawn by two horses. It forms a stratum at least eight feet thick, and is in layers from 4 to 8 or 10 inches thick; it is divided by joints with about the frequency desirable for convenience in quarrying. Its exposures (it is thought that the red Potsdam quartzyte is not seen in that vicinity), are between 5 and 20 feet above the Split Rock creek; and it is quarried at two places, or more, partly upon each side of the creek, which there is probably 75 feet lower than at the Palisades.

No such rock, nor anything comparable with it, is found associated with the Potsdam quartzyte, either in Dakota or Minnesota, north and northeast of the Palisades. No fossils have been seen in the "chalk-rock," nor in any portion of the Potsdam formation, at the Palisades, by Mr. Patten, who has excavated several hundred loads of the "chalk" for his dam. Excepting the beds thus called "slate," "pipestone" and "chalk-rock," the two former of which are clearly seen to be layers in the Potsdam formation, all the extensive exposures of its beds at the Palisades are the ordinary quartzyte, having its usual characters in respect to color, hardness, bedding and joints. No conglomerate was observed here; ripple-marks were seen on the bedding-planes in a few places. Rarely this stone, probably through the influence of weathering (perhaps in preglacial ages), has a soft and somewhat friable structure; this has been noticed

by Mr. Patten in some outcrops within a quarter of a mile from the Palisades; and four miles to the northeast a somewhat soft, pinkish sandstone (probably an altered form of this quartzyte) has been encountered in digging wells. The next exposures of the Potsdam quartzyte south of the Palisades are reported to be nine or ten miles distant, at the east side of the Sioux river, on the upland. Only a few miles further south, this quartzyte outcrops in the extreme northwest corner of Iowa.

The "Devils Gulch" is two and a half miles north-northeast from the Palisades and is a similar canon-like gorge, a half mile long, at the east side of Split Rock creek, on a trifling tributary. Its walls of rock are vertical, 30 to 50 feet high, and from 8 to 75 feet apart, with pools of water ten feet deep in the bottom of the gulch. The rock here is typical Potsdam quartzyte, dipping two and a half or three degrees (four to five feet in a hundred) towards the south-southeast, or, more exactly, S. 30° E. Here some parts of the walls, as also at Dell Rapids and the Palisades, are so intersected by vertical joints, nearly at right angles and from six inches to two feet apart, that the wall resembles ancient masonry, the separate rocks being rounded at the edge by weathering. It is also not uncommon to find places at the surface of this rock, where it similarly resembles the square paving blocks of stone sometimes used for streets. The Palisades and this Gulch seem to me equal in picturesqueness; both being worth going far to see, especially in this region of infrequent rock exposures.

No glacial striæ were observed at the Gulch nor at the Palisades.

XIII.

CHEMISTRY.

REPORT OF PROFESSOR DODGE.

THE UNIVERSITY OF MINNESOTA,
CHEMICAL LABORATORY.
MINNEAPOLIS, MINN., Oct. 6, 1884.

Professor N. H. Winchell,

DEAR SIR: I herewith report to you the results of the analyses made by the chemical department for the state geological survey since my last report. The present report comprises the analyses of nineteen siliceous rocks, numbered in the chemical series from 148 to 166 inclusive; also the analysis of a sample of impure graphite, and the analyses of two samples of water.

These analyses have been made almost wholly by Mr. C. F. Sidener, now instructor in the chemical department.

Very respectfully yours,
JAMES A. DODGE,
Prof. of Chemistry.

Chemical series No. 147. The water of Big Stone lake. The composition of the mineral matter dissolved in this water has been found to be as follows:

	Parts per million.	Grains per gallon.
Silica	106.50	6.2090
Carbonate of iron	2.20	.1283
Calcium carbonate	110.50	6.4455
Magnesium carbonate	63.00	3.6748
Magnesium sulphate	148.05	8.6358
Potassium sulphate	12.48	.7280
Sodium sulphate	95.63	5.5781
Sodium chloride	15.12	.8819
Phosphates	traces	
	553.48	32.2814

The amount of organic matter was such as to require 1.32 parts of oxygen per million parts of water for its oxidation. Yet this amount is not very excessive, being rather less than that in the Mississippi river just above this city.

The water is remarkable for the large amount of sulphates; also for a rather large proportion of silica.

RESULTS OF CHEMICAL ANALYSES OF SILICEOUS ROCKS.

CHEMICAL SERIES NOS. 148–166.

	Chemical series No. 148.	Chemical series No. 149.	Chemical series No. 150.	Chemical series No. 151.	Chemical series No. 152.	Chemical series No. 153.	Chemical series No. 154.	Chemical series No. 155.	Chemical series No. 156.	Chemical series No. 157.	Chemical series No. 158.	Chemical series No. 159.	Chemical series No. 160.	Chemical series No. 161.	Chemical series No. 162.	Chemical series No. 163.	Chemical series No. 164.	Chemical series No. 165.	Chemical series No. 166.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silica, SiO_2	66.36	53.71	57.50	48.81	73.72	65.56	52.54	71.15	71.99	73.28	76.68	69.66	66.72	50.31	7. .58	81.86	73.91	75.19	48.92
Alumina, Al_2O_3	13.33	14.96	13.29	23.27	12.82	10.06	13.50	12.40	12.36	11.83	12.14	11.49	7.41	14.17	13.36	9.87	14.89	10.78	18.45
Sesquioxide of iron, Fe_2O_3	7.89	14.45	11.62	11.80	2.51	14.40	15.35	5.21	4.99	4.61	3.16	3.95	10.13	10.96	3.78	1.44	2.27	4.01	16.88
Protoxide of iron, FeO	2.96	3.65	4.54	3.66	0.22	0.23	3.60	0.75	0.56	0.56	0.52	0.60	0.69	1.09	0.69	2.36	1.70	1.05	0.57
Lime, CaO	2.14	3.35	6.12	5.15	1.70	0.96	6.51	1.90	0.85	1.04	0.25	2.64	3.10	8.44	0.81	0.46	0.27	2.36	0.70
Magnesia, MgO	1.20	4.59	1.63	1.72	0.35	0.73	3.73	1.13	0.72	0.36	0.26	0.71	4.06	5.86	0.18	0.81	trace	0.95	3.68
Potash, K_2O	3.05	0.56	0.80	0.75	2.40	2.88	0.37	2.40	2.45	4.50	3.53	1.08	0.42	0.46	2.48	0.45	2.78	0.93	1.32
Soda, Na_2O	2.63	1.40	1.85	2.38	2.70	2.25	1.10	1.70	0.99	1.66	1.06	1.15	0.86	0.90	2.42	1.61	2.64	1.93	0.48
Water, H_2O	1.21	1.60	1.48	2.53	0.94	0.86	3.34	2.12	2.92	1.82	1.66	8.55	5.32	7.63	1.14	1.43	1.01	1.42	7.14
	100.77	98.27	98.83	100.07	97.36	97.93	100.04	98.81	97.83	99.66	99.26	99.83	98.71	99.72	98.44	100.29	99.47	98.62	98.14

Chem. series No. 167. Sample of impure graphite, from near Aitkin.

Carbon (graphite)	41.28	per cent.
Silica, SiO_2	43.23	"
Oxide of iron, Fl_2O_3	2.02	"
Alumina, Al_2O_3	10.70	"
Lime, CaO	0.46	"
Magnesia, MgO	0.05	"
Undetermined matter	2.26	"
	100.00	

Chem. series Nos. 168 *and* 169. Brine from the Humboldt salt well.

Ingredients dissolved in the water.	Parts per million.	Grains per gallon, U. S.
Silica, SiO_2	208.5	12.15
Alumina, Al_2O_3	40.9	2.38
Carbonate of iron, $FeCo_3$	18.56	1.08
Sulphate of lime, $CaSo_4$	1,990.2	116.08
Sulphate of magnesia, $MgSo_4$	1,236.4	71.12
Carbonate of magnesia, $MgCo_3$	1,347.5	78.60
Chloride of magnesium, $MgCl_2$	1,567.6	91.44
Chloride of calcium, $CaCl_2$	2,684.0	156.55
Chloride of potassium, KCl	724.3	42.26
Chloride of sodium, NaCl	47,402.5	2,764.99
Phosphoric acid	traces.	....
Total solids	57,220.46	3,336.65

Proportion of common salt, NaCl, in the total dissolved solids, 82.8 per cent. The samples from the depths of 180 feet and 450 feet were united, and the analysis above expresses the composition of the brine thus obtained. That from the depth of 450 feet was apparently some stronger in sodium chloride than that from 180 feet.

Chem. series, No. 170. Analysis of water of the Mississippi river taken at Brainerd:

Ingredients dissolved in the water.	Parts per million.	Grains per gallon U.S.
Silica, SiO_2	18.2	1.0616
Alumina, Al_2O_3	3.9	0.2275
Carbonate of iron, $FeCo_3$	4.205	0.2453
Carbonate of lime, $CaCo_3$	111.07	6.4787
Carbonate of magnesia, $MgCo_3$	27.72	1.6169
Carbonate of potash, K_2Co_3	6.0	0.3499
Carbonate of soda, Na_2Co_3	19.36	1.1292
Sulphate of soda, Na_2So_4	3.0	0.1749
Chloride of sodium, NaCl	1.5	0.0875
Nitrates	traces	traces
Phosphates	slight traces	slight traces
Total solids	194.955	11.3715

	Parts per million
Oxygen required for the oxidation of organic matter by the permanganate test	1.28

Chem. series, No. 171. Assay of a sample of ore for gold and silver.

Results: Gold none; silver none.

Chem. series, No. 172. Assay of a sample of ore for gold and silver.

Results: Gold none; silver $5\frac{4}{10}$ Troy ounces per ton of ore.

Chem. series No. 173. Supposed fossil shells in catlinite. (See before, page 103.)

NOTE.— The foregoing substances were derived as follows:

No. 147. Water from Big Stone lake, obtained by C. L. Herrick.

No. 148. Geol. survey number 1 B.; finely crystalline red syenite. Duluth.

No. 149. Geol. survey number 7; finely crystalline brown syenite. Duluth.

No. 150. Geol. survey number 19; crypto-crystalline, or amorphous, yet sparsely porphyritic with red feldspar and slightly amygdoloidal with epidote. Duluth.

No. 151. Geol. survey number 46; fine dark rock, thickly porphyritic with red feldspar, from Brewery creek. Duluth.

No. 152. Geol. survey number 68; "streamed," light red, metamorphic rock, with translucent laminations and specks. From near London.

No. 153. Geol. survey number 74; brick-red, rather fragile, apparently gritty and subcrystalline. At the mouth of Passabika river.

No. 154. Geol. survey number 117; "Two Harbor rock," crypto-crystalline, brown, conchoidal fracture, heavy.

No. 155. Geol. survey number 124; purplish red granite, from the west bluff at the entrance of Beaver bay.

No. 156. Geol. survey number 127; gray quartzyte, mouth of Beaver creek, Beaver bay.

No. 157. Geol. survey number 134; red granite, from the third island below Beaver bay.

No. 158. Geol. survey number 139; rock of the bulk of the Great Palisades.

No. 159. Geol. survey number 140; red, laminated, or "streamed," at the base of the Great Palisades.

No. 160. Geol. survey number 149; red, shaly, sandrock, associated with conglomerate, half a mile below the first falls of Baptism river.

No. 161. Geol. survey number 161, A; brown, aluminous vein-rock, crystalline (?), from trap-rocks at the town line between ranges 5 and 6 (on sec. 36), east of Pork bay.

No. 162. Geol. survey number 203; the red rock at Grand Marais, furnishing the pebbles of the beach.

No. 163. Geol. survey number 262; slaty, pinkish quartzyte, at the head of Wauswaugoning bay.

No. 164. Geol. survey number 285; red granite, from the first island N. W. from Belle Rose island, south of Pigeon point.

No. 165. Geol. survey number 555; red sandstone or quartzyte, fine grained, from the north side of Siskiwit point, Isle Royale, formerly quarried for building stone.

No. 166. Geol. survey number 809; red shale, from the quarry at Fond du Lac, resembling the pipestone of southwestern Minnesota, but softer and more sectile.

No. 167. Graphite from the vicinity of Aitkin, from Mr. —— Palmer, said to be from a well which struck the rock at 18 feet, situated two miles N. W. from Aitkin, apparently in a bed in the rock of the region.

No. 168. Brine from the Humboldt well, in Kittson county, from the depth of about 180 feet; artesian.

No. 169. Brine flowing from the large pipe at the Humboldt well, from the sandrock at the depth of 450-500 feet.

No. 170. Water from the Mississippi river at Brainerd, obtained by Dr. Howe in August.

No. 171. Iron ore, from Mayhew lake, north of Grand Marais.

No. 172. Rotted trap-rock, from T. 64.7 W., sec. 23, supposed to contain gold. From E. M. Fowler.

No. 173. Small slab of pipestone, Museum register number, 5,559; to scrape off the supposed fossil shells and test for phosphorus or lime.

N. H. WINCHELL.

XIV.

MINNESOTA GEOGRAPHICAL NAMES DERIVED FROM THE DAKOTA LANGUAGE, WITH SOME THAT ARE OBSOLETE.

BY PROF. A. W. WILLIAMSON.

[NOTE.—Pronunciation is indicated by respelling the word in a phonetic alphabet identical with that of Dr. Riggs' dictionary, except that the digraphs ch, gh, kh, sh, and zh, are used for his dotted c, g, k, s, and z, and only one form of n. A as in far; e as a in fate; i as in machine; o as in note; u as in rule; ch as in charm; kh as German ch; gh subvocal of kh, *i. e.*, continuant of g; zh as z in azure; t, k, p, w, h, s, and z as in English; b and m nearly as in English, but made nearer together; n and d approach each other still more, it being difficult for an unpracticed ear hearing some words spoken by some Indians to determine which of the two is used; n when it ends a syllable is sounded as Canadian *voyageurs* sound n in bon, much more strongly than the same sound is given by Parisians. Most Dakotas very slightly nasalize all their vowels, and in the case of a succeeded by k this nasalization is quite perceptible to a practiced ear; as, however, it is an entirely different sound from the nasal represented by n, it is obviously improper to confuse words by representing it in the same way, and being an accidental sound of no etymological value and scarcely perceptible in pronunciation, it does not seem desirable to represent it at all. That we should write Makato instead of Mankato is evident in this, that *maka* means earth and *manka* skunk, and no Dakota in saying blue earth would in any case use the strong nasal sound represented by n, and which if used would lead the hearers to suppose he meant, blue skunk. It is said that Fremont (Nicollet's map) wrote Mahkato and the h was changed to n by a broken type.]

Anoka (anoka),—on both sides; name applied by founders to the city laid out on both sides of Rum River, and since applied to the county.

Chaska (chaske),—first born child if a son; applied to the village by its founders.

Chapah (chapa),—beaver; the Dakota name of Beaver creek, a tributary of the Minnesota, and still retained on old maps.

Chanka sndatatah (chanka sdata),—*chan*, wood; ka, kindle;

sdata, feeble; the name applied to the Big Sioux river on Nicollet's map, as given by the Dakotas, but I think not in use of recent years. The Dakotas still call the Firesteel, a tributary of the James, or Dakota, Chanka.

Chanshayapi;—*chan*, wood; *sha*, red; ayapi, are on; Redwood river; so called by the Dakotas on account of the abundance of a straight slender bush with red bark, which they scraped off and smoked, usually mixed with tobacco. This name is spelled by Nicollet Tchanshayapi.

Chetanba wakpa (chetanbe wakpa),—*chetan*, hawk; *be*, nest; *wakpa*, river or creek; Hawk creek, a tributary on the north side of the upper Minnesota.

Cokato (chokata),— choka, the middle; ata, at; the name of a station on the Manitoba Railway.

Chokio (chokaya),— the middle; the name of a station on the H. &. D. Ry.

Dakota (dakota),—alliance league; the name by which the Dakotas called themselves; now applied to the territory, to a county, and to a village in Minnesota, etc. Lakota, a village in North Dakota, is the same word in the Titon form.

Eyota (iyotan),—greatest, most; name of a town in Olmsted county.

Hoghanwanke kin,—*hoghan*, fish; *wanke*, lies; *kin*, the; the place where the fish lies, the Dakota name of the St. Croix. For legend see Neil's *Minnesota*, p. 94.

Hokah (hutkan),— root; the Dakota name of Root river, retained on old maps, and now the name of a village in Houston county.

Imnizha ska,—*imnizha*, ledge; *ska*, white; the Dakota name of St. Paul, given on account of the white sandstone cropping out in the bluffs.

Intpah (intpa or inkpa,—k and t interchangeable before p),—end; the Dakota name of Lac qui Parle creek, flowing into the river at the end of the lake.

Inyan tankinyanyan,—*inyan*, stone; *tankinyanyan*, big; the Dakota name of Big Stone lake. The name is translated on Nicollet's and other old maps. It is so named on account of the large number of drift boulders along its shores.

Inyan sha,—*inyan*, stone; *sha*, red; the Dakota name of *Red Rock*, near St. Paul. A few rods from the river, near the house of Mr. Ford, an early settler, was a large egg-shaped syenite boulder, believed by the Indians to be the abode of a powerful

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spirit, which they worshiped by keeping the stone carefully painted red, and by offerings of food. Every stone and every other natural object was believed by the Dakotas to be the abode of a spirit, but hard, egg-shaped stones only were worshiped.

Ipakshan,—crooked; *Mdeipakshan*, crooked lake, another name given to Big Stone lake, referring to its shape; *wakpa ipakshan*, crooked river; the Dakota name of the Big Sioux river.

Isantamde, knife lake; one of the Mille Lacs, found with variant spellings in the Dakota form, and translated, on old maps.

Isanti (isanati or isanyati),—*isan*, knife; *ati* dwell on or at; the Dakota name of the part of the nation occupying Minnesota, and comprising the Sissetons as well as those now known as Santees; it is supposed the name was given as this lake was their chief location for a time on their westward journey; the name of a county.

Ishtakhba,—*ishta*, eye, *khba*, sleepy; the name of an eminent Dakota chief, a firm friend to the whites, who was the first signer of the treaty of 1851. The name was probably applied to Sleepy Eye lake about 50 years ago, when his band planted there. Nicollet's map names it Sleepy Eye lake; it is now also the name of the village near it.

Iyedan (iyedan),—*mde*, lake; *iye*, speaks; *dan*, diminutive suffix, forms mdeiyedan, the Dakota name of Lac qui Parle, given as *iyedan* lake on old maps; it is very uncertain how it received the name; one tradition says from an echo on its shores; but it is doubtful if any such existed; another tradition is that when the Dakotas first came to the lake voices were heard, but they found no speakers; some think the word has changed its form.

Iyakhba,—sleepy ones; the name of the Iowa Indians and the country occupied by them. Early explorers state that this is the Sioux (Dakota) name. It is probable that 200 years ago the Santees pronounced this word as the Titons now pronounce it, Iyakhwa. As the kh is a sound not found in French it was often omitted, and usually expressed by h, if at all, which occasionally occurs. The spelling *Ayavois*, as given by Le Sueur, is as near to this word as could be expected.

Izuza (izuza),—whetstone; the Dakota name of Whetstone creek, a tributary of the Upper Minnesota; the Dakota form is retained on Nicollet's map.

Khakha,—falls; the Dakota name of St. Anthony's Falls, as pre-eminently *the falls*.

Khakha wakpa,—falls river; the Dakota name of the Mississippi river.

Kandiyohi (kandiyohi),—*kandi*, buffalo fish; *y*, euphonic; *ohi*, arrive in; name of the lake which still retains it, since given to the town and county.

Kanpeshka (kanpe ska),—name of a round, curved, white medal, made of shell and worn by the Dakotas, and probably given to the lake a little west of the boundary on account of suitable shells for making these ornaments which were found there.

Kaposia (kapozha, the *p* written by Dr. Riggs with a dot subscript to denote a peculiar palated modification),—light; the name of Little Crow's band, and the site of their village four miles below St. Paul on the opposite side of the river. The name was given in honor of their skill in the favorite game of *lacrosse*, in which one band played against one, or sometimes against two others, for large stakes. Success depended largely on swiftness (lightness).

Kasota (kasota),—clear or cleared off; the name sometimes applied by the Dakotas to the naked ridge or prairie plateau south of the village of that name, and now applied also to a creek running through it.

Mahtomedi (matomde),—*mato*, the gray bear, *ursus maritimus*, *mde* lake; the Dakota name of White Bear lake, now the name of a camp situated on it*.

Mahtowa: *mato* grizzly bear; *wau*, one; name of a station on Duluth Railway, north of Hinckley.

Mankato (makato),—the Dakota name of Blue Earth river, the name of the city as now spelled would in Dakota mean blue skunk (see remarks on pronunciation, *ante*).

Mayawakan (maya wakan),—*maya*, steep banks; *wakan*, wonderful, sacred, mysterious, here properly translated remarkable; the Dakota name of the Chippewa river, tributary to the Minnesota; the Dakota form is given on many old maps. It is said that *Chippewa* is our translation of the Dakota work Khakhatonwan, dwellers at the falls, *i. e.*, Falls of St. Mary, and that it was applied because the Dakotas sometimes spoke of it as the river down which they came.

Mdewakanton,—dwellers at the lake; a name applied to the part of the Santees occupying eastern Minnesota and western Wisconsin, said to have been given because they still continued for a time on lake Superior after the other Dakotas left it.

* A well-known summer resort, near the village of White Bear lake, near St. Paul.

Mdechan,—*mde* lake; *chan* wood, Wood lake; the Dakota name of the lake where General Sibley gained the decisive victory over the rebel Dakotas, Aug. 23, 1862.

Mdehdakinyan,—lake lying crosswise; the Dakota name of lake Traverse, it lying crosswise to Big Stone lake.

Mde Minnesota (mde minisota),—sky-tinted lake, or having water nearly clear, but with a slight whitish tint; the Dakota name of Clear lake near Fort Ridgely; the Dakota form is given on some old maps.

Mdeyata,—*mde*, lake; *ata*, at; at the lake; this expression was used by the Dakotas in speaking of lake Superior, regarded by them as pre-eminently *the lake*, and so not specially named.

Mde tanka, great lake, signifying the ocean, of which they retained distinct traditions.

Mdeyatanka,—*mde*, lake; *ya*, they speak, say; *tanka*, large; the lake spoken of as large; the Dakota name of Ottertail lake.

Mendota (mdote),—the mouth of a river; name of a village at the junction of the Minnesota and Mississippi. Those living at a distance usually spoke of it as Khakhamdote, junction with the Falls river, *i. e.* the Mississippi river.

Maka re ozey (maka khe oze),—yellow banks; the Dakota name of the Yellow Banks river, a tributary of the upper Minnesota.

Magha tanka,—big goose, *i. e.* swan; the Dakota name of Swan lake, Nicollet county.

Minneapolis,—*mini*, water; *polis*, Greek for city; how the *a* got in seems very uncertain, some regard it as merely euphonic, others as the Dakota prefixed preposition *a*, on, others as an abbreviation of the Dakota *kha*, falls, while still others, but I think with little plausibility, derive it from the Greek.

Minnehaha (minikhakha),—*mini*, water; *kha kha*, falls; khakha is derived from *kha*, curl, being the frequentative form used with *mini*, water, meaning falls; used with *i* mouth, meaning laughing. To translate Minnehaha, "laughing water," though not strictly accurate, is certainly an allowable poetical license; the name of the well known cascade near Fort Snelling; the Dakotas usually called it, chistina, small, in distinction from St. Anthony's falls.

Minneinneopa, or Mineopa, (mini inonpa), *mini*, water *inonpa*, second; the name of a beautiful cascade near Mankato, so called because the second of two falls near together.

Minneiska (mini ska),—*mini*, water; *ska*, white; the Dakota

name of the creek so called; as well said by Rev. A. L. Riggs "the i has no business there," yet it dates back to Nicollet's map.

Minneota (mini ota),—much water, a station on the Winona and St. Peter Railway, said to be so named by an early settler on account of an abundance of water flowing into his well.

Minneola,—*mini* water; *ola*, Latin diminutive, said to have been invented as a parody on Minneapolis, and applied to a township in Goodhue county, as the settlers thought its euphonious sound typical of the beauty of the country.

Mini wakan,—the wonderful water; the Dakota name of Devil's lake, said to have been applied on account of its being so large, and having no outlet. Wakan is persistently translated devil by many frontiersmen, but it is in no case used in that meaning. In names it is nearly always an adjective, meaning wonderful, remarkable; in other cases as an adjective, it means mysterious, sacred; as a noun it always means god.

Minnesota,—(mini sota), water nearly clear but slightly clouded, as that in the Minnesota river, so called by the Dakotas. This river is on old maps called St. Peter's, a name given by the French explorers.

Minnetonka (mini tanka),—great water; the name of the beautiful lake and summer resort near Minneapolis.

Minnewashta,—*minne*, water; *washte*, good; name of a lake known as "White Bear Lake," then "Lake Whipple," and since changed to Minniwashta, by act of the legislature, situated in Pope county, near Glenwood.

Okabena (hokahbena),—*hokah*, heron; *be*, nests; *na*, diminutive suffix; the nesting place of the herons; the name of the lake at Worthington.

Okaman (hokahman),—*hokah*, heron; *man*, nests; the name applied to mills near Lake Elysian, said to have been applied by the Dakotas to the same site. Man and be are variant forms of the same word. The loss of the h in these two words is accounted for by the lighter stress laid on this sound by Dakotas.

Okheyawabe,—*okhe*, hill; *yawabe*, referring to its being much visited; the Dakota name of Pilot Knob, back of Mendota.

Oiyuweghe,—the crossing; the name given by the Dakotas to Travers des Sioux, because they usually crossed the Minnesota here, in going from the upper to the lower villages.

Omaha,—the Dakota name of the Omaha Indians; applied to a small creeek in Southwestern Minnesota, on old maps.

Ojata (ozhate),—forks; the name of a station near Grand Forks.

Owatonna (Owotonna),—straight; the Dakota name of Straight river, on which the city of Owatonna is situated.

Pajutazee (pezhihutazi, abbreviated from Pezhihutazizi ka pi),—*peji*, generic name, including grasses and all other erect plants without wood stems; *huta*, root; *zi*, yellow; *kapi*, they dig; diggings of yellow plant root, or yellow medicine diggings; the Dakota name of the Yellow Medicine river, written by Nicollet Pejuta zizi; the name as first spelled was the name given by Dr. T. S. Williamson to his station, and is found in this form on a number of maps.

Ptansinta,—probably of *ptan*, otter, and *sinte*, tail; the name of the Dakota village at the head of lake Traverse.

Re ipa (khe ipa),—*Khe*, hill or ridge; *i*, prefixed preposition, to; *pa*, head; the Dakota name of the "head of the Coteau."

Remnicha (Khemnichan),—*Khe*, hill; *mni*, contraction of *mini*, water; *chan*, wood; the Dakota name of Red Wing, given on account of the union of these features there; applied also to Hay creek flowing into the Mississippi there.

Sappah (sapa),—black; the Dakota name of Black river, Wisconsin.

Shakopee (shakpi),—six; the Dakota chief of the band formerly occupying the site of this city was *Shakpidan*, Little Six. The usual Dakota name of the band was Tinta tonwan, Dwellers on the prairie.

Shunkasapa,—*shunka*, dog; *sapa*, black; Black Dog, a Dakota chief, and name of his village near Hamilton station, Omaha Railway.

Sisseton (sisin towanyan),—*sissin*, fish scales; *towanyan*, village; the most numerous clan of the Santee Dakotas. They occupied in common with the Wahpetons, nearly all Minnesota west of Carver, except the extreme northern part. The name was given them when they were further east, living principally on fish, and in one village.

Tamaha—pike; the Dakota name of Hudson; for legend see Neil's *Minnesota*, p. 94.

Tanpayukedan—*tanpa*, white birch; *yuke*, is there; *dan*, diminutive; the Dakota name of Birch Cooley, where our forces under Maj. Brown fought a disastrous battle in 1862.

Tchanshayapi, see Chanshayapi.

Tintah (Tinta),—prairie; a station on the Manitoba Railway.

Tintatonwan, see Shakopee.

Tipsinna,—a farinaceous bulbous root, a much used and highly prized article of food; the name applied to the Pomme de Terre, or apple river. The French is a translation from the Dakota, the English a mis-translation from the French.

Wahnatan (waanatan),—he who makes an attack; a celebrated Sisseton chief, formerly the name of a county in Minnesota.

Wabasha (Wapaha sha),—red battle-standard; as *wapaha* is also used to mean hat, this is sometimes incorrectly translated "Red Hat;" the name of the chief whose land occupied the country below lake Pepin and had their village on Winona prairie, which was for many years called "Wabashaw prairie" by steamboatmen and early settlers; it is now the name of a city and county, but the oft repeated statement that this was his residence is erroneous.

Wacouta (wakute),—he shoots; the name of the chief whose band was located at Red Wing; the name of the railway station next south of Red Wing.

Wahpeton (wakhpetonwan), *wakhpe*, leaves; *tonwan*, dwell, dwellers among the leaves, one of the four Santee clans; (see *Sisseton*), a town in Dakota.

Wahpekutey (wakhpekute),—leaf shooters, the smallest of the four Santee clans. They lived chiefly in the valleys of the Blue Earth and Cannon.

Wakinyan oye,—the thunderer's track; given by Nicollet who translated it lightning's track; the name of three small lakes near Big Stone lake. The Dakotas say that these tracks were made by the infant Thunder-god, probably the most worshiped of their deities.

Waraju,—*wagha*, cottonwood; *zhu*, pour, plant, etc.; the name applied by the Dakotas to the Cottonwood and Little Cottonwood rivers on account of the Cottonwood groves so frequent along them. The word *little* is, in Dakota, chistina, and placed after the noun.

Watonwan,—this word might mean "I see," or "he sees," intransitive; it may have been applied to this branch of the Blue Earth as being a prairie country and presenting a good prospect, but it is uncertain whether this is the meaning on which the appellation was given; the Dakota name of the river, now used for the county, also,

Waseca (wasecha),—rich, especially in provisions. I was informed in 1855 by a gentleman who was a stranger to me, who professed to be one of the first settlers, that this name was

given in response to inquiries as to the Indian word for fertile, and adopted as a name. In Dakota writing and books the word *waseca* is spelled as we spell the name, and is a word likely to be given in answer to such a question. The soil is also very fertile. I have since several times seen it stated in print that the word is a corruption of *washichun*, white man, given on account of a solitary white man residing there, but I am unable to ascertain that there was any such resident, or that any Dakota ever gave the place this name, and think the first derivation much more probable. It is the name of a city and county.

Wasioja (wazi ozhu),—*wazi*, pine; *ozhu*, place in, etc.; the Dakota name of the Zumbro river, given on account of the scattered pines; retained on old maps and applied by the whites to a village in Dodge county.

Wastedo,—*washte*, good; *do*, emphatic particle; name of a post office in Goodhue county.

Waubay (wabe),—place of hatching of birds; name of a lake and town west of Millbank, Dakota.

Wayzata (wazi yata),—*wazi*, north (also pine), *ata*, at; the name of the station at the north end of Lake Minnetonka.

Winona (winona),—first born if a daughter, diminutive of wino woman; the name of the city built on what was formerly called "Wabashaw's prairie." The name of the band was *Kiyuksan*, breakers in two, or violators, so called because they violated the custom forbidding relatives, however distant, to marry.

Yankton (ihanktonwan),—end village; the clan of Dakotas formerly occupying the southeast part of Dakota. It is said that this name was given when their village was at the west end of Lake Superior, but this is uncertain.

In preparing the above I am greatly indebted to an able article in *Iapi Oaye*, January, 1883, by Rev. A. L. Riggs, and to information obtained from my father, Dr. T. S. Williamson.

A. W. W.

XV.

ENTOMOLOGY.

BY O. W. OESTLUND.

MINNEAPOLIS, MINN., April 1, 1885.

Prof. N. H. Winchell, State geologist:

There is probably, at present, not a crop in this state more threatened and injured by insects than the cabbage. It is for this reason that I submit the following list and notes on insects injurious to the cabbage, as they were observed last summer on the experimental farm of the State University, incomplete as they may be when applied to the whole state, being the observations of but one season and confined to one county. Still, I hope they may have some value to the farmer and gardener in their endeavor to become familiar with and to overcome these pests; being the first record of several of these insects as occurring in Minnesota, they will also have their scientific value.

INSECTS INJURIOUS TO THE CABBAGE.

1.—*Pieris rapæ, Schrank—The white or imported cabbage butterfly.*

This is the most common and destructive of our cabbage insects. It was introduced from Europe, where it also proves quite destructive to the cabbage, about thirty years ago, and has already spread over the greater part of North America, proving that introduced species often flourish exceedingly, and become even more destructive than native species of similar habits. It has, apparently, already settled down for good in this state, and can be considered as a permanent addition to our insect-fauna. I believe that this species is so well known that no description

is necessary for its identification, but as we have several other species similar in habit and hardly less injurious, I shall give a short description of all of them, so that they can be more easily compared and identified by the intelligent farmer and gardener, who may wish to know something about the destroyers of their labor and how they may best free themselves from them.

Description.

The eggs.—These are laid by the white butterfly that we see hovering around our gardens as soon as the tender plants are ready to be set out in the spring, and are continued to be laid for successive broods during the whole season whenever the weather is at all favorable. They are very small; fusiform; ribbed longitudinally, which can be easily seen by a lens; of a light yellowish color, but which soon becomes darker. Generally they are found singly or only a few together on the under side, but also occasionally on the upper side, of the leaves.

The larvæ.—The larvæ, or worms, as they are more commonly called, are rather sluggish in their movements; of a velvety-green color, with black dots, a pale yellowish stripe down the back, and a row of yellow spots on each side. They are generally found in all sizes, from those just hatched to the full grown one, about one and a half inches in length. They are also found to feed upon the cauliflower, turnip, mustard, and other cruciferous plants, though they seem to be very partial to the cabbage.

The chrysalis.—The chrysalis is really an object of beauty and wonder, although we destroy it without consideration, as it proves so destructive to our garden if allowed to develop. It is about three-fourths of an inch long; angulated, and pointed at both ends; in color it varies with minute black dots from grayish-green to quite light. It is found suspended by a web of silk at the end of the body, into which the hooks of the posterior end are twisted, and also by a thread of silk, stretched around the back and fastened to the board, fence or stone under which the larva has chosen its place for transforming.

The imago.—The full developed butterfly has the body black and quite hairy; the wings white above, with a dusky or black space at the tip of the fore wings, and several black spots disposed in a line on the middle of the wings; on the under side the hind pair of wings are yellowish, the fore pair only so on the anterior part. It expands from two to two and a half inches.

Subject to parasites and sickness.

Several parasites are already known to occur in this country on the larvæ of this species, and they will probably prove an effective check on the too great increase in the future. As far as known, none have yet been observed in this state, but if not actually here they will be as sure to occur in due time as the butterfly itself. Parasites generally do spread a great deal slower than the insect on which they live. The larvæ are also known to be subject to some kind of sickness that occasionally carries them off in great numbers. During the past season this has proven to be very generally the case in this state. The cause of this sickness, or epidemic as it might well be called, has not yet been made out to satisfaction, but very probably it is, as has been suggested by some entomologists, some kind of fungus disease or rot, which is favored by the dampness of the weather and the slow vital energies of the larvæ during such times; for it has been observed that during long rains and continued dampness it is very prevalent among the larvæ, while during dry, or only showery, weather, it is rare. The larvæ as soon as affected cease to feed and become even more sluggish in their movements; their bodies become very pale and soft, and some time after they can be seen hanging from one of their legs, or fallen to the ground, and the contents of their body dissolved and running down as a black fluid, leaving only a black streak on the cabbage leaf as the remains of their former existence.

Preventives and remedies.

Whenever the insect can be destroyed in any of its stages it will prove an effective preventive, especially if it be the female. Generally we do not pay any attention to the chrysalids, even if we find them in great numbers on the fences, in the rubbish, etc., around our garden, but we let them all develop into the white butterfly, and this we allow to fly unmolested over our cabbage plants until they have been well stocked with the future brood; and not until the larvæ have become so numerous that they threaten to devour our whole crop, or at least seriously damage it, do we look around for some means of saving it. A great many remedies have been experimented on and proposed, but mostly they are either too costly or impracticable in their application to become of general use. When the crop is too

large to be taken care of by hand-picking, which is the cheapest and surest way in a small garden, we have found the application of hot water to be one of the best. It was tried several times last summer at the experimental farm of the State University, and with very satisfactory results. The thick leaves of the cabbage are such that they can stand water being sprinkled on them at a boiling point without any bad effect, and it will prove a sure destruction to all the larvæ. A good and careful cultivation is also very important. If we neglect our garden or field it will become only a too fit place for injurious insects, and remedies that we may apply will be of little use, while in a clean and well cultivated garden the injury will seldom become serious.

2.—*Plusia brassicæ, Riley.—The cabbage Plusia.*

This is one of the most destructive species to the cabbage in the southern states. It has been recorded as far north in the Mississippi valley as Illinois, but I think this is the first notice of its occurence in Minnesota. I have taken it repeatedly during the last season, both in Ramsey and Hennepin counties, where it by no means is a rare insect; and the extent of its injury is hardly less than that of the foregoing species. From present indications we have much to fear from it in the future. Few of our farmers and gardeners seem to be aware of its existence, but this is probably from the different habit that this species has from the foregoing and more common white cabbage butterfly. The imago, being a moth, is seldom ever noticed in the cabbage field, and the larvæ are in size and color somewhat similar to those of the white butterfly and can therefore be easily overlooked by the untrained observer. The food-plants of the larvæ in their native state are several of our wild herbs, but unfortunately they have also taken a liking to several of our garden plants, as the cabbage, turnip, tomato and celery.

Description.

The eggs.—According to Prof. Riley the eggs are pale, greenish-yellow in color, somewhat convex, and about .55 mm in diameter (.02 inch). From the centre radiate numerous elevated ridges which are divided by transverse and less distinct ridges. They are very loosely attached, either singly or in small clusters, to the leaves, for the most part to the upper, but exceptionally to the lower surface.

The larva.—The larva is light green in color, with several faint white lines along the back; thickest at the posterior end and somewhat tapering in front. It is one of the so-called loopers, and on being disturbed or in rest will raise the middle of the body so as to form a kind of loop and remain in this position sometimes for a long while. It eats long, irregular holes into the cabbage leaves. According to Prof. Riley the larvæ of this species are subject to several parasites and often to a fungus disease, and as they live exposed on the outside of the plant are often devoured in great numbers by birds. As far as my observations go with regard to these points in Minnesota, the larvæ were ordinarily found on the underside of the cabbage leaves, and of all the species I have observed as injurious to the cabbage, this one has been the healthiest and least exposed to parasites. I have raised several hundred of these larvæ and a very small per cent failed to reach maturity, and during cold and damp weather, when nearly every larva of the white butterfly was affected by disease, and even some of the other native species showed weakness, this species seemed to remain unaffected. This would lead us to infer that the species has lately extended its range into this state and has not yet been followed by its ordinary enemies, and finding here an uncontested field, increases without check. If this proves to be so we have much to fear for the coming years until the parasites will also have extended as far.

The pupa.—The pupa is about three-quarters of an inch long; dark brown in color. It can easily be seen through the very loose web-like cocoon that the larva spins around itself before undergoing the transformation. The place for transforming is generally on the leaf or stalk of the plant on which the larva has been feeding.

The imago.—The moth is of a grayish-black color, with a patch of silvery white on the fore pair of wings, and a spot of the same color immediately below this patch; the hind pair of wings are lighter colored, with posterior half blackish and surrounded by a fringe of white; the underside of the moth is of a dull silvery-gray.

Remedies.

This species has shown itself better able to withstand the application of insecticides than any other, and will therefore be

more difficult to get rid of. Hot water will kill the larvæ if it reaches them. We shall probably have to look to the natural enemies as the best check here as elsewhere, if they should prove to become as common as the white butterfly.

3.—*Plutella cruciferarum, Zell.*—*The cabbage Plutella.*

This little moth is very common over the greater part of the United States, and, like closely related species in Europe, proves very destructive to the cabbage, turnip, and similar plants. From the small size of the larva and moth of this species it seems to have been very generally overlooked in this country, and the mischief done by it ascribed to that of the common white butterfly. It has been found very common in Ramsey and Hennepin counties during the past season, and undoubtedly already exists over the whole state where cabbage is cultivated. Fortunately it only attacks the outer leaves, leaving the head uninjured; but it is incessantly at work on those, riddling them with small holes. And during very dry seasons, when they sometimes do multiply exceedingly, they may prove very destructive to the cabbage, and greatly stunt and retard the growth and the formation of the head.

Description.

The eggs.—Eggs were at several times noticed that very probably will prove to be those of this species. They were very small, oblong, about half or a little more than as broad as long; fastened from their side and not base as in those of the white butterfly; color white or whitish; surface very much wrinkled. Generally found singly, but often in clusters of two or more together or in a row.

The larva.—The larvæ are a little over a quarter of an inch long; cylindrical, gradually tapering from the middle towards both ends; color pale green; head and first segment commonly pale yellow. On being disturbed they have a very active wriggling motion, moving briskly backwards or letting themselves fall to the ground by a fine, web-like thread.

The pupa.—When about to pupate the larva spins for itself a very beautiful, gauze-like cocoon, through the wide meshes of which the pupa can plainly be seen, and can generally be found very plentiful on the outer leaves on which the larva feeds. The

pupa itself is about one-fourth of an inch long, of a white color, with the black eyes at the base of the antennæ very conspicuous.

The imago.—The moth measures about .30 in. in length to the tips of the closed wings, and when at rest the antennæ are directed in a straight line forward, and not turned backward as is generally the case. On being disturbed by walking through the cabbage field, it can be seen flying with a very quick motion, but only for a short distance, when it will again alight on some plant until disturbed.

Remedies applied to the other species are also generally very effective on this.

4.—*Ceramica picta, Harris.—The Zebra cabbage worm.*

Harris, some thirty years ago, called attention to this species as occasionally injurious to the cabbage, cauliflower, spinnach, beet, and other garden vegetables with succulent leaves. It has since, at several times, shown itself quite destructive to the cabbage, especially during dry seasons, when the wild plants, upon which it ordinarily lives, have become dried up. It was taken at several times on the cabbage during the last summer, in Minnesota, and must, therefore, be put down as one of our insect enemies to the cabbage against which we need to be on our guard. The larva is very conspicuous on account of the bright yellow markings, or bands, on either side. It lives, exposed, on the leaves of the plants on which it feeds.

Description.

The larva.—When young the larvæ are almost black. They are then gregarious in habit and can be found from twenty-five to fifty or more on a single leaf, but as they grow older they spread all over the field. When full grown they are about two inches in length, of a velvety black color, with the head, legs and under side tawny red; on each side there are two lateral yellow lines and bands, between which are numereus transverse, zebra-like lines, giving to the larva a very characteristic appearance.

The pupa.—The larvæ when full grown go into the ground and there change to the pupa, which is about three-fourths of an inch long, in color shining brown, and rather thickly punctured.

The imago.—The moth is nocturnal in habit, and therefore

seldom seen in the field. It is about the same size as the Plusia moth, but brown in color, shaded with purple-brown. It has three spots on each of the fore wings, edged with gray, and a transverse zigzag line, forming a more or less distinct W in the middle, near the outer margin. The hind wings are white, faintly edged with brown on the upper and outer edges.

On account of the larvæ when young having a gregarious habit, they can then be easily destroyed by cutting off the infested leaf and destroying it. The eggs are hatched in the early part of June, and the young colonies of larvæ should then be looked for.

5.—*Mamestra chenopodii, Albin.*—*The cabbage Mamestra.*

No injury has been reported or observed as caused by this species in the state, and so far only a few larvæ have been taken on the cabbage; but as it has shown itself very destructive to the cabbage in other parts of the country, it may, under favorable circumstances, become even as destructive here as elsewhere. The larva is easily distinguished from any of the foregoing by a lateral line along its body of pinkish color; the green color varies considerably, from a dark to a light green. The pupa is found in the ground, and the moth is of a yellowish-gray color, varying sometimes to a dark brownish gray. It has not got the silvery spots on the fore wings like those of the Plusia. In case the larvæ of this species should become very numerous and troublesome in this state, entomologists have recommended as the best remedy the use of poisoned turnip leaves as a trap. The leaves should be well covered with a London purple or Paris green solution and placed at intervals along the rows.

6.—*Murgantia histrionica, Hahn.*—*The harlequin cabbage-bug.*

During last summer some of the very characteristic eggs of this species were taken on the cabbage on the experimental farm of the University, giving indications of a new insect pest for the cabbage in this state. It is a southern insect, but has been known to extend its range northward from year to year, as the Colorado beetle extended its range eastward, though its progress has been a good deal slower. It has been recorded in the Mississippi valley as far north as Illinois, and Professor Lintner, in his first report as state entomologist of New York, intimates

that it is capable of extending its range as far north as to include Minnesota and Wisconsin. In the south it is one of the most destructive insects to the cabbage. It is not a larva or worm like the foregoing species we have noticed, but it belongs to the order Hemiptera, or true bugs, such as the plant lice, squash-bug, and similar ones, which are provided with a beak, or *rostrum*, as it is called, which they thrust into the plants on which they live and imbibe the sap, thereby injuring or killing the plant when they become very numerous. Although only the eggs have as yet been observed in this state, it is very probable that in the near future we shall have all the stages, and if it should prove to be as destructive here as further south we have another species that will not stand back to that of the white butterfly in the extent of its injury. I shall therefore call attention to it that our farmers and gardeners may be on the watch. As I have not had the opportunity to study this species in the different stages, having only seen the eggs, I shall give the description of Prof. Lintner, found in the report alluded to above. Any information or inquiry with regard to this species will be gladly received.

Description.

Eggs.—The eggs are beautiful objects, and are easily recognizable. They are cylindrical, with rounded extremities, placed on end, and cemented together by their sides. They are white, tinged with green, apically, with two black bands, the upper one of which is twice as broad as the lower, and placed a little nearer to the extremity of the egg. The apex is strikingly marked with a black crescent bordering the slightly-depressed lid (which opens upon a hinge for the escape of the larva), and occupying rather more than one-half of its circumference. The length of the egg is about one-half greater than its diameter, measuring .034 inch by .052 inch. They are arranged in two to four rows of three to six eggs in each row.

The larva.—The larvæ are small, pale-green, and when more advanced become orange-colored.

The pupa.—The pupa resembles the perfect insect in marking and coloring, but may be at once distinguished by having wing pads instead of wings, and is not capable of flight.

The imago.—Measures three-eighths of an inch in length by nearly one-fourth in width. It is conspicuously marked in shining blue-black, dull orange and white, as follows: The black

head has two short lines upon it of yellowish white; the thorax is orange, with a ring of black on each side, centered with a triangular orange spot, or with the black diminished and the ring either interrupted or broken into two spots. The coriaceous portions of the wing-covers are orange, crossed obliquely by two black bands, and their tips are black. The scutel (the large triangular piece covering the central portion of the body) is black, with a pale yellow spot at each anterior angle, a black terminal tip and a central cross of orange. Beneath, the joints of the abdomen bear upon their margin a row of triangular white spots, and intermediately there are three rows of particolored spots in orange and white.

No parasites are as yet known to prey upon this species, and it has been found very difficult to destroy by any ordinary application of insecticides.

7.—*Aphis brassicæ, Linn.—The cabbage plant-louse.*

The Aphidæ, or plant-lice, become at times the greatest torments to the gardener and agriculturist. There is hardly a plant that has not a species or more of this pest living upon it, and often great injury is done. The plant-lice belong to the order Hemiptera, or true bugs, and, like the foregoing species, are provided with a beak, which they thrust into the plant and suck the juices. The cabbage plant-louse has been found more or less common through the state, and is probably the most widespread species of those injurious to the cabbage. They are found in clusters or colonies on the upper side of the inner, or under side of the outer, leaves, but also sometimes solitary. The colonies are made up of wingless individuals of all sizes, and, further on in the season, also of winged individuals.

The young individuals are egg-shaped and of a dull, pale-green color, and their bodies dusted over with a pale-grayish powder. Antennæ and legs dusky black.

The females, or largest wingless individuals, are also coated with a gray, meal-like powder; egg-shaped and of a dull, yellowish-green color; eyes black, and also two large spots on the crown and one on each side of the neck; antennæ black, with the third joint yellowish. The nectaries, or honey-tubes, are short and black, as are the legs; base of the thighs pale-yellowish; body plump, large and unwieldy in its aspect, and about a tenth of an inch in length.

Winged individuals are dull-greenish in color, varying to pale dull-yellowish, and largely varied with black.

Remedies.

Fortunately this species has a great many enemies that ordinarily keep it within bounds, and it is only occasionally that they do multiply in such great numbers as to destroy or seriously damage a crop. Whenever a leaf is found affected it should be cut off and destroyed, so as to prevent, as much as possible, the spreading over the whole field. When very numerous, kerosene emulsion has been found very effective.

8.—*Haltica pubescens, Illiger.*

9.—*Crioceris striolata, Fab.*

The flea-beetles.

The little flea-beetles, as they are called on account of their jumping to an incredible hight on being disturbed, are very similar in habit and appearance to each other. They are found destructive, not only to the cabbage, but to most of our garden vegetables, by nibbling small holes into the leaves as soon as they come out of the ground, and continue to do so during the whole season. Often they so injure a bed of vegetables as to necessitate replanting. They are both very small, less than a tenth of an inch, and shining black; the second with a broad, wavy, buff-colored stripe on each side, and the feet reddish-yellow. The thighs of the hind pair of legs are very much thickened, like those of the grasshopper, giving them the great leaping power. They have been found very difficult to get rid of by any ordinary application of insecticides. Ashes sprinkled over the young plants will drive them off, to some extent. Frogs are known to destroy them in great numbers when found and allowed in gardens.

Other species will undoubtedly have to be added to this list in the future, as observations extend, but still we should hope not, as the cabbage-grower surely has sufficient with the evil as it at present appears.

Respectfully,

O. W. OESTLUND.

XVI.

THE CRYSTALLINE ROCKS OF THE NORTHWEST.*

I desire to call the attention of Section E to some of the interesting problems that beset the geologist who undertakes to study the crystalline rocks of the Northwest, and especially that part of the Northwest which is included in the state of Minnesota. Until very recently it has been the practice of geologists, almost without exception, to refer every crystalline rock in the Northwest either to the Huronian or to the Laurentian. Thus, when the survey of the state of Michigan was reinaugurated in 1869, the geologists of the upper peninsula were compelled to choose between a confession of their inability to establish the age of the rocks they were studying and the adoption of some of the recognized designations. In Wisconsin the case was similar, with the additional fact that the Michigan geologists were collaborators. The same was true again in Minnesota. What more natural than that the Michigan and Wisconsin rocks should be found to extend, with nearly the same features, into the state of Minnesota, and that their familiar names should at once be applied to them?

But when on more careful examination, both in the field and in the literature of the crystalline rocks, and over a wider extent of territory, and especially in the light of more recent researches in New England, New York, Pennsylvania, and Canada, it is found that the nomenclature is imperfect, and furnishes but a tottering scaffold to support the workmen of a great and ever-spreading structure, we are thrown into such difficulty and doubt that we are prone either to reject the old scaffold and build anew, or to clear away the accumulated rubbish about the foundation and examine on what basis the old one stands. To-day, however, we intend to do neither of these, but rather set forth a few of the incongruities and difficulties of the actual situation.

*Address of N. H. Winchell, Vice-President of Section E, at the Philadelphia meeting (1884) of the American Association for the Advancement of Science.

We are indebted, unquestionably, to the geologists of Michigan and Wisconsin for the most exhaustive and satisfactory description of the crystalline rocks of the Archæan age that has yet been published in America. In order that some of the difficulties of the situation may be made clear, I desire to review concisely the broad stratigraphic distinctions of the crystalline rocks that have lately been studied in Michigan, Wisconsin and Minnesota. By the aid of the published results of the surveys of Brooks, Wright, Irving, Rominger, Pumpelly, and others, a generalized statement can be formulated. To these I shall add such published results and unpublished field observations from Minnesota as may be furnished by the survey of that state, in order that the scheme may cover correctly the crystalline rocks of the entire Northwest.

Omitting the igneous rocks, which in the form of dykes cut through the shales and sandstones of the Cupriferous formation, and are interbedded with them in the form of overflows, we may concisely arrange the crystalline rocks, disregarding minor differences and collating only the broad stratigraphic distinctions, in the following manner, in descending order:

There are six groups:

First group.

Granite and gneiss with gabbro.—This group is represented in Minnesota by the gabbro and red syenite at Duluth, and by the extension of this range of hills northeastwardly nearly to the international boundary. Its thickness is unknown, but certainly reaches several hundred feet. The outcrop of red granite near New Ulm, lying under the conglomerate and red quartzyte, is probably in the southwestward line of extension of this group. This group is represented by No. XX southwest of lake Michigamme, by No. XX at Menominee and by No. 1 and 1a at Black river.

Second group.

Mica schist.—This group consists of schists that are micaceous and often staurolitic as well as garnetiferous. It can be seen in Minnesota on the Mississippi river at Little Falls, and at Pike rapids. The schists are variously associated with beds and veins of granite and gneiss. This is No. XIX at Marquette, XVII to XIX

at Menominee, XX to XXII at Penokee, and has a maximum thickness of 5,000 feet.

Third group.

Carbonaceous and arenaceous black slates, and black mica-schists. —These sometimes pass into roofing slates, with beds of iron ore, quartzyte and dioryte. This group includes the black slates of the Animikie group in northern Minnesota, of Knife lake and Knife portage on the St. Louis river, and carbonaceous slates lately reported near Aitkin on the Mississippi river. It includes Nos. XIV to XVII at Marquette, Nos. VI to XVII at Penokee, and Nos. XV and XVI at Menominee. Thickness 2,600 feet.

Fourth group.

Hydro-mica and magnesian schists.—Soft and obscure, becoming quartzose and also hæmatitic, also with numerous beds of dioryte. In Minnesota this is the iron-bearing horizon at Vermilion lake. It is Nos. VI to XIV at Marquette, Nos. IV to VI at Penokee, and Nos. VI to XI at Menominee. Maximum thickness 4,450 feet.

Fifth group.

This is the group of *gray quartzyte and marble.* It is represented by No. V at Marquette, Nos. II to V at Menominee and Nos. I to III at Penokee. In Minnesota this horizon seems to run along the south side of Ogishke Muncie lake, near the international boundary and includes perhaps the great slate-conglomerate which is there represented. Normal thickness from 400 to 1,000 feet; but if the great conglomerate of Ogishke Muncie be included here, the thickness of this group in northern Minnesota will exceed 6,000 feet.

Sixth group.

Granite and syenite with hornblendic schists.—This lowest recognized horizon has frequently been styled Laurentian. In Minnesota it is found on the international boundary at Saganaga lake, and large boulders from it are included in the overlying conglomerate at Ogishke Muncie lake, showing an important break in the stratigraphy. Thickness unknown but very great.

These six great groups compose, so far as can be stated now, the crystalline rocks of the Northwest. Their geographic relations to the non-crystalline rocks, if not their stratigraphic, have been so well ascertained, that it can be stated confidently that they are all older than the Cupriferous series of lake Superior, and hence do not consist of nor include metamorphosed sediments of Silurian or any later age.[1]

This statement of the grand grouping of the crystalline terranes of the Northwest may be varied by the addition of detailed and minor distinctions and by subdivisions, but its correctness rests upon careful observations and reports of competent geologists, and cannot at present be gainsaid.

Examining these groups more closely we find:

I. We have beneath the red tilted shales and sandstones, a great *granite and gabbro group*. This has been variously regarded by different geologists. While by many early observers it was classed as older than the series which has latterly been designated Huronian, and by others styled igneous and local, it has by Brooks been placed with that series and denominated "the youngest" of the Huronian strata, though no such rocks had ever before been mentioned as pertaining to the Huronian. By Irving it has been made the base of his Kewenawan. By Hunt it has been parallelized with the Montalban. It includes, in my opinion, the felsytes and porphyries which have been styled Arvonian, and it is very certain that in many places it has passed for typical Laurentian. The gabbro is very generally admitted to be of eruptive origin, and in its great development in Canada it was once styled Upper Laurentian, and later was known as Norian. While the gabbro is certainly eruptive, the associated granite and gneiss exhibit evidences of being metamorphic in their nature. In northern Minnesota this horizon of granite is characterized by a red color and it has an aggregate chemical composition almost identical with that of some of the associated felsytes. The magnetite of the gabbro is often highly titaniferous and so abundant that the rock has attracted attention as an iron ore. The gabbro does not always appear where the granite is present, but extensive areas of granite are spread out without any sign of variation, interruption or alternation with the gabbro. In other places these two rocks are intricately and intimately mingled both horizontally and perpendicularly; but the gabbro may be considered in

[1] The term Silurian here is understood to cover nothing below the base of the Trenton.

general as the underlying formation. Both these rocks seem to have been molten, and simultaneously so, in some places; but in the great mass of the red, granitic rock, there is a gneissic structure, and in its finely crystalline state, when it seems to vary to felsyte, it exhibits a laminated structure which is evidently due originally to sedimentation. Along these laminations, and coincident with them, is a finely lined striation which exhibits the "streamed" structure, sometimes appealed to, to show the igneous nature and origin of the rock. These felsytes are occasionally arenaceous, with irregularly rounded or subangular quartz grains, and sometimes are porphyritic with quartz and orthoclase. Veins of red granite intersect the gabbro, and the gabbro surrounds isolated masses of the granite. Transported, boulder-like masses of both are found embraced in a common paste among the later igneous outflows of the Cupriferous, where their existence is as great a puzzle as that of pebbles of red felsyte and quartz-porphyry in the red conglomerates. This red granite, so far as I have observed, generally consists largely of orthoclase, and in several instances passes imperceptibly into red felsyte. It contains also quartz and hornblende, the latter generally changed by decay. The gabbro, when unaffected by proximity to the red rock, consists of the three essential ingredients: labradorite, diallage and magnetite, with some necessary products of alteration, but in the vicinity of contact with the red rock it also holds orthoclase and quartz.

II. Below this granite and gabbro group is a series of strata that may be designated by the general term *mica schist group*. This is the principal, but not the only, horizon in which mica schist exists. This division is penetrated by veins and masses of red biotite-granite, which appear to be intrusive in somewhat the same manner as the red granite in the gabbro overlying. However, whether this granite is exotic, or can be referred to aqueo-igneous fusion and transmission of the sedimentaries in a plastic state through fissures in the adjacent formations, is a question which still is a matter of earnest investigation. The existence of the great associated igneous gabbro is suggestive, if not demonstrative, of the presence of an adequate agent for such a metamorphism—unless it be claimed, indeed, that such an extravasation of molten rock could take place without any marked and traceable effect on the contiguous formations. These granite veins penetrate only through the overlying gabbro and this underlying mica schist. They are wanting or comparatively

rare throughout the rest of the crystalline rocks. On the other hand there is an abundance of diabase and other doleritic rock, in the form of dykes, throughout all the crystalline strata. This points to the mere local nature of the origination of these granitic veins, and hence to the metamorphic nature of the granitic mass with which they are connected. It has been shown by Dana that granite suffers a change to mica schist, in western Massachusetts; Brooks, as well as Emmons, has shown it interstratified with limestone in St. Lawrence county, New York. They both also state that the Potsdam sandstone becomes gneissic. The same has been affirmed in Vermont by Dr. Hitchcock, and by Dr. Frazer in Pennsylvania. Hence, there is no impropriety in supposing that some great change has passed over the sedimentary strata of this horizon throughout a wide extent of country reaching from the Atlantic to lake Superior, and that in the emergences of upheaval and dislocation the sediments of one formation were enabled to penetrate transversely into the strata of another.

This mica schist formation has an aggregate thickness of about 5,000 feet, and sometimes is hornblendic rather than micaceous.

III. The next lower grand division, which is the third, might be styled the *black mica slate group*. This group contains much carbon, causing it to take the form of graphitic schists, in which the carbon sometimes amounts to over forty per cent.[2] These schists are frequently quartzose, and also ferruginous, even composing valuable ore deposits, as at the Commonwealth mine in Wisconsin. Associated with these black mica slates, which often appear also as dark clay slates, are actinolitic schists, the whole being, in some places, interstratified with dioryte. Their estimated thickness is 2,600 feet.

IV. Underneath this is a very thick series of obscure, *hydromicaceous and greenish magnesian schists*, in which, along with beds of gray quartzyte, and clay slates, occur the most important deposits of hæmatitic iron ore. The lower portion of this series, which at Marquette is represented rather by hornblende and chloritic quartz schists, and more rarely is mined as a magnetic quartz schist, at Penokee is known as "the magnetic belt." This division of the crystalline rocks has numerous heavy beds of dioryte.

V. Below this series of soft schists, which terminate downward

[2] A recent analysis of a specimen from near Aitkin, Minnesota, showed between forty-two and forty-three per cent of carbon.

with the magnetic iron ores, is the great *quartzyte and marble group*. The marble lies above the quartzyte, and in the Menominee region has a minimum thickness of at least one thousand feet; while at Marquette it graduates into a dolomitic quartzyte of indefinite extent, the whole group there being essentially a quartzyte. This is a most persistent and well-marked horizon. The quartzyte sometimes holds feldspar; thus having an appearance of granulite. In northern Minnesota, the great slate-conglomerate of Ogishke Muncie lake seems to represent the lower portion of the great quartzyte of this group, and to be the equivalent of the lower slate-conglomerate of the "typical Huronian," in Canada. In both places this conglomerate is sometimes speckled with masses of red jasper. The marble of this group appears adjacent to the conglomerate south of Ogishke Muncie lake, and in such a position as to overlie it, exposing a thickness of at least twenty-two feet.

Now, the difficulties of the situation arise when we cast about to find names for these parts. What are the eastern representatives of these western groups, and by what designations shall they be known?

Since the geological survey of New York, and the publication of its final report, the progress of geological science in Europe and America has rendered it necessary to revise some of the dogmas which were regarded as fundamental by the New York geologists, and to reject entirely some others. Among these may be mentioned the then current theory that the term "primary" should be applied to any massively crystalline rock, and that all such rocks belong to the bottom of the chronological scale of geology. If the apparent structural relations of the formations, as seen in the field, did not agree with this theory, some violent movement in the earth's crust was at once conjectured so as to bring nature into accordance with the true theory. Latterly, however, it has been shown abundantly by Dana and others, that the Trenton, Hudson river and other Silurian rocks are converted into crystalline schists; by Whitney that the Tertiary rocks become crystalline; by Brooks and Frazer that the Potsdam sandstone becomes gneissic; by Reusch that the clay slates, interbedded with the granites and gneisses of the Bergen peninsula of Norway,[3] contain characteristic Upper Silurian fossils, and by Hitchcock that the Helderberg rocks of New York are involved in the crystalline terranes of New Hampshire.

3Lesley, Report C4.

These more recent crystalline series, however, may all be considered as excluded from the scope of search for any parallels to the crystalline groups of the Northwest. Our inquiry will involve only the well-known names Laurentian, Huronian, Taconic, Montalban, Arvonian, Norian.

We meet at the outset with the question which has now become as historic in American geology as the Cambro-Silurian controversy in England, and which concerns very nearly the same geological horizon, viz.: Is there a formation such as claimed by Emmons — the Taconic? On this geologists are yet divided. We conceive, however, that the division is caused, not so much by doubt as to the existence of a sedimentary fossiliferous formation below the New York system, and separating it from the "primary," as by doubt as to which and how many of these sub-Silurian strata are to be included in the designation of Taconic. Having now, however, given the subject very careful consideration, I am ready to state my very positive conviction that Dr. Emmons was essentially right, and that the Taconic group will have to be recognized by geologists and adopted in the literature of American geology.

Dr. Emmons, in 1842, issued the first that appeared of the volumes of the final report of the New York survey. In that volume he formally sets forth the Taconic system, although, as he admits, in an imperfect manner, the area in which the rocks exist not being in his (the second) district. In this first presentation of the system he extended it geographically too far east, and unfortunately chose a name for it which is appropriate only to a part of that eastward extension. We are indebted to the researches of several volunteer geologists, Wing, Dana, Dale, Dwight, for the disentanglement of the overlying Hudson river rocks from the true Taconic rocks, and the demonstration of the incorrectness of Dr. Emmons' eastward extension of his system in southern Vermont. Dr. Emmons' claim, however, in all its essential points, remains intact. This consists in the existence of a series of sedimentary deposits, largely metamorphic, below the Potsdam sandstone, and separating the Postdam from the crystalline rocks known as "primary," in an orderly chronological scheme.

In his report on the agriculture of New York, issued four years after that on the geology of the second district, he makes more definite and convincing statements, going over the whole subject *de novo*. He gives diagrams showing the Taconic slates lying below the Calciferous sandrock unconformably, at White-

hall in Washington county, a region that had been colored by Mather and Hall on their geological maps as Hudson River, and lying in the general area described by Emmons as Taconic. He gives one also from the hills of Greenbush, opposite Albany, not far from the locality in which Mr. Ford has since discovered primordial fossils, where he also shows the Calciferous lying unconformably upon the Taconic, the former being fossiliferous. He also describes the Hudson River slates as lying unconformably on the Taconic, a fact which cannot be called in question since the recent discoveries of Wing, Dale and Dwight, and the stratigraphic investigations of Dana. In fact, the investigations of these geologists, instead of destroying the Taconic system, are only confirmatory of the published statements of Dr. Emmons in 1846.

Although the existence of the Taconic in Maine and Rhode Island, as claimed by Dr. Emmons, may not be maintained by further research, it is certain that he had the approval of Dr. Douglas Houghton in extending it into the state of Michigan. In later years, he also traced these rocks through Pennsylvania and Virginia into North Carolina. In Michigan his identifications have since been set aside and the same rocks have been denominated Huronian by Brooks, Wright, Irving and others. In North Carolina Mr. Kerr has, in the same way, substituted the name Huronian. The conclusive fact that these slates had been seen by Dr. Houghton, in many localities, to pass beneath the Potsdam sandstone, was considered ample to supply the only important point of evidence lacking in the Hudson valley. Dr. Emmons closes his discussion by stating his theme thus, referring to the facts obtained from Dr. Houghton: "It would be difficult to add to the weight of this testimony in regard to the separate and independent existence of a system of fossiliferous rocks, of an age anterior to the Silurian or New York system."

It is not necessary to refer to the controversies that arose from the creation of the imaginary Quebec group, nor to characterize in deserved terms the attempt to bury the Taconic in the Quebec coffin. It is not necessary to quote the support which Emmons had from Barrande, nor to recount the discoveries of Mr. Ford, nor the observations of Brooks in St. Lawrence county, N. Y., and Rogers in Pennsylvania, though these last both affirm that beneath the Potsdam sandstone are extensive beds of semi-crystalline strata.[4]

[4] Address of H. D. Rogers, 1844, before the Assoc. Amer. Geol. and Nat.

There may be reasons why the current literature of American geology is almost silent respecting the great work of Emmons, and why the Taconic is not known among the recognized geological formations; but we have nothing to do with these at this time. We have to say now only that it seems necessary to admit that when Dr. Emmons insisted on a great group of strata belonging to the age of the Lower Cambrian, lying below the Potsdam sandrock in New York, he had some foundation more substantial than imagination or mere hypothesis. He may have chosen an unfortunate designation, he may have but imperfectly understood the extent and importance of his discovery, and he may have incorrectly described its range and scope, but none of these faults, nor all of them, should deprive him of the credit of having made the discovery. He did more, he defended it to the last day of his life, and averred that "the Taconic system stands out as boldly as the Carboniferous."[5] The argument against the Taconic system, which appeals to imperfect or incorrect definition by its author, will apply with equal force against the Silurian system and also against the Cambrian; also against the Huronian and Laurentian, and perhaps with still greater force against the Hudson River, since none of these were correctly and properly defined at first by their authors.

If the equities of geological nomenclature, in the light of the results of later researches, demand of geologists of this generation a fair consideration of the claims of Dr. Emmons, that consideration must be granted. No amount of error, though heaped to the sky and supported by the highest authority, can long subsist. The truth, though tardy in asserting itself, will finally throw off the burdens under which it has labored, and will shine the brighter for the darkness which preceded it.

If we examine the descriptions, given by Dr. Emmons, of his Taconic system, we shall find that he makes the following broad stratigraphic distinctions:

I. His highest member is what he designates *black slate*, which he declares, in some cases, plunges apparently beneath the "ancient gneisses" and contains a considerable amount of carbonaceous matter. In this slate, at Bald mountain, were found two genera of primordial trilobites that were described by Dr. Emmons, the much buffeted *Atops trilineatus*[6] and *Elliptocephala asaphoides*.

[5] Letter to Jules Marcou, dated Raleigh, N. C., Nov. 6, 1860.

[6] According to Mr. Ford this is *Conocoryphe*.

II. Under the black slate his next grand distinction was the so-called *Taconic slate*, which he described as argillaceous, siliceous and "talcose," the upper part being suitable for roofing and other portions adapted for flagging. It is greenish, grayish and sometimes of a chocolate color. Its grain is very fine, but in some places it is arenaceous rather than argillaceous. Thickness about 2,000 feet.

III. Below this great mass of soft schists, he described, in the first place, a mass of 500 feet of limestone, designated "Stockbridge limestone," which graduates downward into "talcose" or magnesian sandstones and slates, the whole having a thickness of about 1,700 feet.

IV. Under this limestone is his "granular quartz-rock," more or less interstratified with slates, and becoming, in some places, an immense conglomerate with a "chloritic paste." In this conglomerate are fragments of the underlying gneiss, or

V. A formation which constituted, in his scheme, the "ancient gneiss" on which the Taconic system was said to lie unconformably.

Now it requires but a glance to perceive how closely this order coincides with that which has been independently and laboriously worked out in the Northwest. We have in both instances a "black slate" which in one case is said to be at the top of the system, but to pass apparently beneath the "ancient gneisses," and in the other is reported to be overlain by a group of mica schist and the "youngest Huronian," a mass of gneiss and gabbro. Below the black slate in both cases is an immense series of soft, hydro-mica and magnesian schists. These again are followed by limestone which in the Northwest often forms marble, and in New England sustains extensive marble quarries. This has various transitions to slate and to a hard sandrock, but in both places it becomes known, in its lower portions, as a great bed of quartzyte; and finally at the base is coarsely conglomeritic with masses of rock from the great underlying series of gneiss. Were there no other precedent this very parallelism would be taken at once as demonstrative, or at least indicative, of equivalence of age. The "Stockbridge limestone," however, at Stockbridge, seems to be of the Trenton age, according to Professor Dana; and where it appears in the Taconic mountains, further south and west, it is assumed by him to be of the same formation. But no one can affirm safely that the Taconic range of mountains is made up of the Trenton and Hudson River for-

mations till the crucial test has been applied to them successfully in the discovery of the characteristic fossils, and assuredly not, in the absences of this test, in the face of the foregoing parallelism with a limestone known to lie much lower; and in the face of the discovery of primordial fossils in Bald mountain some miles further north in Washington county, New York. It is to be remembered also that the schists of Mt. Washington are distinctly different from those of southern Vermont containing the Trenton fossils found by Mr. Wing, "a change" taking place in them not far south from the point at which the fossils were found, continuing thence to the southern extremity of Mt. Washington.[7]

Now, however, we are confronted with another difficulty. The geologists of Michigan and Wisconsin have set aside Dr. Emmons' identification of the Menominee rocks with the Taconic in 1846, and have called them Huronian, the same that has been done in North Carolina by Mr. Kerr, parallelizing them with the Canadian system, which in 1855 was so named by Dr. T. Sterry Hunt.[8]

It becomes necessary, therefore, to ascertain of what the Huronian consists. Dr. Hunt sets out with the statement that it was designed to include the younger and unconformable series of metamorphic rocks found on the shore of lake Huron and in the valley of the Thessalon river, "and also the so-called volcanic formations of lake Superior." Thus the avowed intent was the same as that of Dr. Emmons in erecting the Taconic system. If we seek for the actual stratigraphic and mineralogical characters of these rocks, we shall find them in the geological reports of the Canadian survey, particularly that of 1863.

In descending order the original Huronian consists of the following strata, disregarding the diorytes and other "greenstones," all of which are thought by Logan to be of igneous origin, though included in the thicknesses given.

White quartzyte	400 feet.
Limestone	200 "
White quartzyte	1500 "
Limestone, siliceous and cherty	400 "
White quartzyte	2970 "
Red jasper conglomerate	2150 "
Red quartzyte or conglomerate	2300 "

7 Dana, *Amer. Jour. Sci.* (3) XVII, 376.

8 Equisse geologique du Canada; Azoic rocks, Rep. E, p. 72.

Slate conglomerate	3000 "
Limestone	300 "
Slate conglomerate	1280 "
White quartzyte	1000 "
Chloritic and epidotic slates	2000 "
Gray quartzyte	500 "
Total	18000 "

Of this series of 18,000 feet, 900 feet consist of limestone; 2,000 feet consist of "chloritic and epidotic slates," and 15,100 feet consist of quartzyte and conglomerate. Perhaps 5,000 feet of this last thickness may be considered intrusive, consisting of dioryte and other forms of "greenstone." This will leave 10,000 feet, at least, for the aggregate thickness of quartzyte and conglomerate, being nearly double that observed in the same horizon in northern Minnesota.

It is plain to see that if there be any parallelism between these beds and the various groups made out in the Northwest, the whole of these strata must be made the equivalent of group v, or the *quartzyte and marble group*. The 2,000 feet of chloritic and epidotic slates, represented as near the base of the original Huronian, followed as they are by an immense thickness of conglomerate and slate conglomerate, are anomalous unless there be below them other slate conglomerates. This, indeed, is very probable, since, on the shore of lake Superior, near the mouth of the river Doré, according to the same authority, the lowest part of the Huronian is seen to consist of a green slaty conglomerate, containing "boulders" of granite and gneiss.

The extension of the term Huronian from the horizon of the original Huronian, upward through the overlying groups, may be justified by the expression of the original intent in the application of the term, but it certainly does not seem warranted by any description of rocks by the Canadian geologists, nor by any claim that usually has been put forth by the authors of the name.

There is, therefore, a conflict between the Taconic and the Huronian, both in respect to the horizon which they are intended to cover (both being referred by their authors to the Lower Cambrian) and in the horizon of rocks which they actually compass. The Huronian, however, in its original and typical description, can be parallelized with only the very lowest of the strata that were included in the typical and original Taconic; while the Taconic stretches upward at least as far as to include

the fourth and third grand groups made out in the Northwest, that is to say, the *hydro-mica and magnesian schists*, and the *carbonaceous and arenaceous black slates.*

This leaves two series of rocks untouched by the scope of either the Huronian or the Taconic, as these systems were at first defined, namely: the *mica schist group* and the *granite and gneiss with gabbro group.* In the term *Montalban* proposed for these groups by Dr. Hunt, the two are united and the constant distinctness which they seem to maintain is not recognized. The granite and gabbro group has affinities with the overlying *Cupriferous rocks*, and perhaps, as Irving has suggested, should be considered the base of that series which Brooks has named "Kewenawian," whereas the mica schist group has affinities with the underlying groups, and has, without exception, been assigned to the same system and age as those underlying groups. The granite and gabbro group has likewise been designated differently. The gabbro, being an igneous rock, varies much in its prevalence and in its apparent relation to the granite. Its greatest development produces in Minnesota a range of low hills which extend northeastward from Duluth. Under similar circumstances, this group has received the name *Norian*, though at first called *Labradorian*, and thought to be a part of the Laurentian.[9] The granite and gneiss, also, associated with the gabbro, have received, under one of their modified conditions, the special designation *Arvonian*, on the supposition that these rocks where they so appear, are not modified conditions of granite and gneiss, but represent independent strata that lie near the bottom of the "Huronian," equal in rank to any of the other groups. I think I have shown elsewhere[10] that the Arvonian rocks of lake Superior are interstratified with the Cupriferous, and also that they are modified sediments of the Cupriferous. Instead of being near the bottom of the "Huronian" in the Northwest, they overlie all the other groups that have been assigned to the Huronian by Irving, and constitute a part of the great series of "younger gneisses" which by Brooks has been ranked as the "youngest Huronian."

The interesting variety of nomenclature, as brought out by the foregoing remarks, can be seen by a glance at the accompanying tabular arrangement, where the various parallelisms and the conflicting nomenclature are placed in adjoining columns.

It is evident from this table that at present it is a hazardous,

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[9] It was described by Emmons under the term "Hypersthene rock."

[10] A. A. A. S. Cincinnati meeting; Minnesota Survey Rep. for 1880, p. 36; *ibid*, 1881, p. 110.

and perhaps an impossible, undertaking to assign the groups of the crystalline rocks of the Northwest to any of the terranes that have been named further east, without violating somebody's system of nomenclature. Some of the ground has been covered several times by different names, but on different hypotheses of structure, origin and parallelism. Respecting the horizon known as "Laurentian," there is an approach to unanimity and agreement. This, however, consists more in a tacit consent to style the lowest known rocks Laurentian, than in any agreement among geologists as to the nature and composition of the strata. The Taconic of Emmons, which has been buffeted and combated from the day of its birth, has from that very circumstance been generally ignored by geologists, because of a certain air of dubious authenticity which accompanies the word. The term Huronian has been allowed to stand and to flourish, partly because of the high authority on which it rests and the remoteness and inaccessibility of the typical locality, and partly, at first, because of the non-publication of Dr. Emmons' protestation that it was the equivalent of some part of his Taconic, and later, because, after Emmons' death, as well as before, his opponents were active in spreading views adverse to the Taconic system throughout the literature of American geology. The original Huronian has grown from the dimensions of a single group (the quartzyte and marble group), so as to include all the crystalline rocks lying above that group, spreading from the Laurentian to the unchanged sediments of the Upper Cambrian. This has become so obviously wrong, in some cases, and has included groups of rocks so plainly extra-Huronian, that a double and triple nomenclature has been applied to a part of these upper rocks, for the purpose of relieving the term of the heterogeneous burden which it was otherwise compelled to carry. These new names, with the exception of Montalban, seem to be of value only as regional designations, the strata which they represent being igneous or metamorphic, and hence liable to be wanting in some places and to be non-crystalline in others. They further complicate the stratigraphic nomenclature, since the strata are probably only the locally modified parts of the same system. Their geographic distribution in the Northwest not only indicates their stratigraphic horizon, but also their limited and local existence.

In conclusion, the chief points brought out in this discussion may be stated more concisely:

1. The crystalline rocks of the Northwest are comprised under six well-marked comprehensive groups.

2. The Taconic of Emmons, so named in 1842, and more correctly defined in 1846, included three of these groups.

3. The Huronian of Canada is the equivalent of the lowest of the Taconic groups, and the perfect parallel of only the lowest of the groups in the Northwest that have been designated Huronian.

4. The uppermost of the groups in the Northwest is local in its existence and exceptional in its character, and has received, therefore, a variety of names.

5. There are, therefore, confusion and conflict of authority in the application of names to the crystalline rocks of the Northwest.

GROUPS.	EMMONS.	HUNT.	BROOKS.	IRVING.	EQUIVALENTS IN MICHIGAN.	EQUIVALENTS IN WISCONSIN.	EQUIVALENTS IN MINNESOTA.
GROUP I. Granite and Syenite with Gabbro.	Hypersthene Rock. (Regarded as part of the primary.)	Montalban. Labradorian. Norian. Upper Laurentian. Arvonian.	Youngest Huronian.	Base of the Keweenawan.	XX.	I and Ia at Black river.	Duluth. Brule Mountain. Misquah hills. Beaver Bay
GROUP II. Mica Schist.		Montalban.	The Huronian of Brooks. 1873.	The Huronian of Irving. 1879.	XIX at Marquette. XVII-XIX at Menominee.	XX-XXII at Penokee.	Little Falls. Pike Rapids. Outlet of Vermilion lake.
GROUP III. Carbonaceous and Arenaceous Black Slate.	Taconic System. 1842-1846. Black Slate.	Animikie.			XIV-XVII at Marquette. XV and XVI at Menominee.	VI-XVI at Penokee.	Animikie Black Slates. Grand Portage.
GROUP IV. Hydromica and Magnesian Slate.	Taconic Slate.				VI-XIV at Marquette. VI-XI at Menominee.	IV-VI at Penokee.	At "The Mission" Vermilion lake. Vermilion Iron Mines.
GROUP V. Quartzyte and Marble.	Stockbridge Marble. Granular Quartz Rock.	The Huronian of Canada, 1855.			V at Marquette. II-V at Menominee.	I-III at Penokee.	Ogishke-Muncie lake.
GROUP VI. Granite and Gneiss with Hornblendic Gneiss.	Primary.	Laurentian.	Laurentian.	Laurentian.	Laurentian.	Laurentian.	Laurentian.

XVII.

GEOLOGICAL NOTES IN BLUE EARTH COUNTY.

BY PROF. A. F. BECHDOLT.

Interglacial peat.— Some time ago Mr. Z. Harrington, of Mankato, showed me a section, a foot long, four inches wide and three inches thick, composed of organic matter, mainly compacted leaves, sedges, etc., and resembling a poor lignite or compressed peat. When first seen it was yet moist, and could be cut like hard soap. The layers, of which it is composed, were also somewhat elastic. On drying it became harder, more brittle, and cut like wood. On Saturday, October 18th, I visited the place, in company with Dr. Harrington, where it is found. This is in Mankato township on the land of Messrs. Pleasanton and Powell, in the bluff of a ravine bearing a stream that flows into the Le Sueur river from the north. This organic deposit is seen in both banks of the ravine, and can easily be traced horizontally about three hundred feet, and then is lost. It has a pretty uniform thickness of about two feet, is overlaid by about six feet of dark drab clay containing some pebbles of quartz, limestone and shale, and disseminated rolled fragments of lignite. This clay effervesces briskly in hydrochloric acid. A similar clay lies under this organic mass, considerably thicker than the upper clay. A short distance further down, into the deeper parts of the ravine, brings to the surface glacial boulders. This seems to me, therefore, to be a mass of organic matter collected in a low place in the glacial clay surface some time during the glacial period, probably toward the close. A fragment is sent with this as a specimen. The rootlets of living plants traceable in this specimen disappear further in the bank when the surface is cut away a few feet.

[NOTE.—This interesting observation of Prof. Bechdolt shows the wide extent of the peat deposit, which accumulated between

two epochs of glacial cold, in southern Minnesota. In eastern Freeborn and in Mower counties it has been found extended over an area of several townships, lying outside of the morainic belt that crosses this part of the state north and south, and yet separating two distinct glacial clay deposits.* In Blue Earth county it is here found on the opposite side of the same morainic belt, and within the area of the glacial activity of the last cold period. If the deposits at these two points were contemporaneous, it is necessary to find some explanation of the extension of till eastward, so as to cover it several miles beyond the supposed farthest limit of the moving ice, in Freeborn and Mower counties, and of the preservation of it from disruption by the ice in Blue Earth county while it prevailed over a great area, and extended into Iowa, as well as of its final burial beneath the six feet of pebbly clay which lies over it. If the deposits at those two points were not contemporaneous, but one succeeded the other by an interval of time amounting perhaps to several thousands of years, allowing the shrinkage of the ice mantle from its outer limit to one of the later stages of its retreat, it will only be necessary to find an explanation for one fact, namely: the extension of till outwardly for several miles beyond the so-called "terminal moraine." But it will be necessary also to suppose the long continuance of the same peat-forming conditions about the southern ice-margin.

If, on the other hand, the till which overlies the peat in Mower county be not the horizontal extension, and equivalent of that which overlies it in Blue Earth county, and there were no lateral extension of the till beyond the ice-margin as above presumed, then the two tills in Mower county, separated by this bed of peat, show the existence of two glacial epochs in Minnesota prior to that which has been described as *the last* glacial epoch, and the clay which covers the peat in Blue Earth county may be a pebbly clay of a semi-lacustrine origin — one of the incidents of the ice-retreat through the Undine region.†

A specimen of this ancient peat from Blue Earth county was sent to Mr. B. W. Thomas, of Chicago, for microscopic examination. He reports: "I send you slides of diatoms, sponge spiculæ, Radiolarius, etc., from the interglacial peat you so kindly sent me. So far as I have yet noted, all of the forms are fresh-water, about the same as those now found in your fresh-water ponds, streams, swamps, etc."— N. H. W.]

* Final report, vol. I, pp. 368 and 390.

† Final report, vol. I, p. 442.

Clays.— On Friday afternoon, October 17th, Mr. S. F. Alberger took me to see the place where he has obtained the pottery clay, containing the Cretaceous leaves. This point is about half way between Chalk run and the farm house on the Le Sueur river bank, and as to thickness, etc., of deposit, and over and underlying matter, are well described on pages 435 and 436, volume one, of the final report of the geological survey of Minnesota. In the cut whence come the fossil leaves, appears on one side a large boss of rock, whether connected with other rock or not within the bank, could not be determined. The part exposed was about four feet each way, is very much water-worn, seems on the surface formed of a white clay very firm and hard. Throughout this clay are scattered, very thickly, little rounded masses of the size of peas, quite distinct in form from the clay, but seeming to possess the same composition. Within, the rock is more siliceous; grains of free sand cover a freshly broken surface. Along the side of the rock mass are markedly seen the lines of stratification, exactly as seen on the water-worn or weathered surface of the Shakopee at the cement works and elsewhere. (See figure 11.)

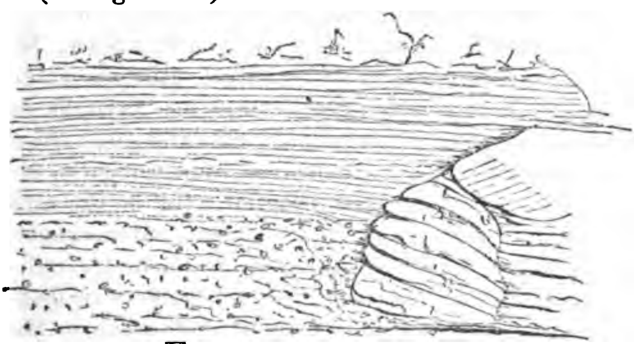

Fig. 11—Clays at Mankato.

A little further along the bluff toward Chalk run is an exposure of the Cretaceous clay, made during last winter. Here the clay rests on a floor of rock, whose edge is not exposed. This rock has the "fawn" color, hardness and general external properties of some of the softer layers of the Shakopee. It is worthy of note that the white clay on the Jordan sandstone is from twenty to thirty feet below this; and incidentally that from fragments of stone found in this white clay on the southeast corner of Chalk run bluff, where it is just now being uncovered for use this winter, the white clay seems to lie on eroded surfaces of the Jordan.

[NOTE.—The following observations were made at the pottery works of Mr. Alberger, in October, based on a quantity of material for use derived from his clay-pit a short distance above the bluff at the railroad crossing, the same point as above illustrated by Prof. Bechdolt. The clay here used contains numerous leaves, and through the kindness of Mr. Alberger a collection has been made and submitted to Dr. Leo Lesquereux, of Columbus, O., for determination. The relative position of the white clay and the other parts of the bluff is here determined by the statements of Mr. Alberger.

In the white (kaolinic) clay lying directly on the sandrock are small concretions of silica, about as large as pin-heads. They have a dull or dirty amethystine color, and are generally in definite horizons, or very thin sheets running coincident with a kind of structural fibre in the clay itself, though in general the clay is homogeneous and massive.

The white clay is sometimes concretionary—at least lumps of a coarsely concretionary, kaolinic, clay, resembling that seen under the Cretaceous at two miles below the Lower Sioux Agency*—are found in the bed which Mr. Alberger uses for tiling and fire brick. They probably appertain to the conglomerate, which is closely associated with the potter's clay at that place. When he screens the conglomerate, in order to get siliceous material for his fire-brick, these concretionary lumps are brought to light. Some pieces are small, like a hickory-nut, and some are as large as a peck measure. They are derived apparently, *en masse*, directly from the bed of decayed material lying on the crystalline rock-surface at the time of the Cretaceous submergence. The most of the white kaolinic clay, as it lies in, under and on the Shakopee and Jordan formations, is supposed to be due to the reassorting and distributing agency of that ocean on that preexisting mass of soft material; said mass being the result of weathering and decay of the crystallines through Silurian and Carboniferous times. In the same conglomerate are silicified corals and brachiopods of Silurian and even Devonian age, found as water-rounded pebbles. Mr. Alberger's tests seem to show that this conglomerate consists of purer silica, though containing some chert, etc., than the sandrock lying under the Shakopee limestone. The underlying sandrock, he says, will fuse in the heat he produces, rather easily, but the crushed pebbles of this conglomerate he cannot fuse.

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* See the second annual report, p. 187.

The following facts and observations were derived from a late visit to the cement works of the Standard Cement company, at Mankato.

1. They do not use the whole rock now, as they did at first, but only the lower ten feet (about ten feet).

2. They have had some poor cement, but this is now obviated by making some selection of the rock.

3. Mr. Bodé, chemist at Milwaukee, has analyzed all the strata, and given careful attention to the differences of composition, the strata being numbered from near the top downward. Nos. 3, 6 and 7 had nearly the same composition, but they are using all below No. 3.

4. The upper portion is burned for quicklime, or is sold at twenty-five cents per load for common building rock, the purchaser hauling it away.

5. The company have sold in advance all the cement they can make from this date to Jan. 1, 1885, and say they will continue in operation into the winter as late as possible, even if they "have to shed the quarry" — the product for the season being from 25 to 30 thousand barrels, at $1.50 per barrel.

6. The irony crust on the Shakopee is not so much due to the superposition of something new, by accretion, on the surface, as to a change in the Shakopee itself to the depth of about half an inch. The crystalline facets of the dolomitic rock can be seen plainly preserved within the irony crust at some distance from the line of transition from the rock to the crust. There is also a somewhat different color and texture in the lower part of the crust.

7. If the clay lying under the limerock is of the same age as the limerock (Cambrian), as supposed by Prof. Bechdolt, and as indicated by the appearances at the quarry, and by the intercalation of their clay beds within the beds of the limerock at higher levels, that seem to be of the same age as that below — I can only explain it on the hypothesis that the Shakopee lies unconformably, near here, on the crystallines, and that at the time of its deposition, a submergence like that which preceded the Cretaceous kaolinic clays, took place, thus bringing the older decayed material within the strata of the Cambrian. If that be the case the Shakopee will be found somewhere near Mankato lying on the crystalline rocks (though here it lies on the Jordan), and the white underlying clay will there be still thicker, though at remoter points the same clay is known to disappear wholly from this ho-

rizon. By a later (Cretaceous) submergence the same process took place again and gave Cretaceous kaolinic deposits, the result of wash from both crystalline and Cambrian areas. This whole hypothesis, however, as yet seems to me unnecessary, since I think all the clay within and under the Shakopee may be attributed to the insinuating action of the water of the Cretaceous ocean on the pre-existing weather-cracks and openings of the Shakopee, carrying the fine clay to the deepest recesses, wherever the water could enter — and especially because we know of no such overlapping of the later Cambrian unconformably on the crystallines.— N. H. W.]

XVIII.

FOSSIL ELEPHANT IN WINONA COUNTY.

BY PROF. JOHN HOLZINGER.

STATE NORMAL SCHOOL,
WINONA, Feb. 11, 1885.

Prof. N. H. Winchell, Minneapolis, Minn.,

DEAR SIR: If my memory serves me correctly, you inquired quite a while ago about some remains of a mastodon supposed to have been found in Winona county, and now deposited in our Normal School museum. I wrote to you then that we have only the remains of a mastodon found near Dubuque, Iowa. And this was in fact all that I knew at the time. Recently when I removed the precious remains of said animal I discovered the incongruity of the crown of a tooth, and a fragment of a tusk with the rest of the skeleton. Since then Prof. Morey, former principal of our school, has gone through the Museum with me, and when I indicated to him the want of agreement in the structure of the several parts, he informed me that the tooth and fragment of tusk did not belong to Prof. Woodman's collection* at all. These pieces, he said, were added during his administration; and he knew positively that they were found by the workmen on the Chicago & Northwestern railway, near Stockton, and that in the same locality was found a large antler of an elk, about three feet long. But the striking point of it all is that tooth and tusk seem to be not parts of a mastodon; but, to judge from the grinding surface, and size of the tooth, they belonged rather to a species of Elephas. The question is, was it the common Elephas primigenius.

Hoping that it is not too late for you to make use of this note, I remain, cordially yours, JOHN M. HOLZINGER.

* The Dubuque specimen had been purchased of Prof. H. T. Woodman.

[NOTE—On making further inquiries concerning the exact location of the finding of these remains, Prof. Holzinger ascertained, from Dr. Cole, of Winona, that he had brought a piece of a tusk from Stockton, taken from a clay-bank within forty rods of the railroad crossing of the highway, and deposited it in the Normal School museum, some twenty years ago. Also, that Hon. Thomas Simpson sent the greater part of the piece of tusk to the museum of the State Historical Society. Mr. Simpson also stated that the tooth now in the possession of the Normal School was found in the same place as the tusk, only a little later, during the cut through the clay-bank. This clay-bank is the loess-loam of the region, lying in the valley where Stockton is situated, between high rock-bluffs composed of the St. Croix and St. Lawrence formations.*

By the kindness of Prof. Holzinger this tooth was submitted for examination and description, and the following notes were made. It is illustrated by the figure on plate II.

It is not an entire tooth, but apparently less than one-half of the original. It is five inches long, fore and aft, on the crown, and three and a half inches in width. Entire plates are wanting from both ends, so that the piece, as shown in the figure, represents the central triturating surface of the crown, well worn. It is five and three-fourths inches deep perpendicularly, with signs of having lost an inch or more. The flat crown shows eight enamel plates (one at each end), the average distance between their centres being three-fourths of an inch. The thickness of these plates, though double, averages less than one-quarter of an inch; and hence the intervening cementum averages a little more than one-half inch in thickness. These plates are, therefore, "attenuated and concentrated," as Falconer remarks of American representatives of the Elephas primigenius. The plate represents the natural size of the crown of the tooth.

The dentine (in the centre of the plates) is so thin in some places as to be hardly visible. The enamel plates are direct and uncrimped, hardly undulating as they pass from one side of the tooth to the other. This might be *Elephas primigenius*, Blu., as that species was at first understood to range in America.

In 1838, Dr. C. Briggs, a member of the corps of the first geological survey of Ohio, first described Elephas Jacksoni, from Jackson county, Ohio, as distinct from E. primigenius, Blu.† and

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* See the final report, vol. i, p. 238.

† Mather's first annual report, 1838. This name was first applied by Briggs in the American Journal of Science, vol. xxxiv, 1838.

Mr. Billings was disposed to have this name cover all specimens, except E. Columbi, "found in America as far north as the United States and Canada," (Canada then was Upper and Lower Canada, and not the Dominion, as now,) including that described by himself from Burlington Heights, near Hamilton, at the western extremity of lake Ontario, found in 1852.

De Kay, however, according to Leidy in "Extinct mammalian fauna" (vol. vi, of the second series of the Philadelphia Academy of Natural Sciences, Journal), named the American specimens E. americanus, a name which Leidy revives and continues, both in the above publication and in the volume of Hayden's survey (vol. i), entitled "Contributions on the extinct vertibrate fauna of the western territories," p. 238. Billings, however, attributes the origination of the specific name americanus Leidy, at the daté of 1853. (See Can. Nat., vol. viii, p. 146.)

Dr. Falconer established E. columbi in 1857, concluding it ranges about the gulf of Mexico and southward. (Natural History Review, Jan., 1863.) He seems to include in it E. jacksoni, of Briggs, and its representatives from other places.

E. imperator, Leidy (1858), was at first thought to be new, because associated, as supposed, with a peculiar geological fauna of a different (earlier) age, but Leidy now rather includes it (with columbi) in americanus, and thinks its relations to the other fossils with which it was reported to be associated are not established satisfactorily.

E. texanus (Blake or Owen, 1858) is satisfactorily proved by Falconer to be a synonym of E. columbi. (Nat. History Review, Jan., 1863.)

Billings in the Canadian Naturalist, vol. viii, p. 146, regards columbi and jacksoni as distinct from each other, and from primigenius.

This Stockton specimen is quite distinct from the Montana specimens described in the tenth annual report, in the thinness of the plates, and the large amount of cementum between them; and if either be different from the primigenius, of Blumenbach, it is that from Stockton, and might be distinguished by Leidy's name americanus. According to Falconer, however, probably the best of English authorities, these would all be classed as primigenius.—N. H. W.]

XIX.

BOULDER-CLAYS.

ON THE MICROSCOPIC STRUCTURE OF CERTAIN BOULDER-CLAYS AND THE ORGANISMS CONTAINED IN THEM. BY DR. GEORGE M. DAWSON, D. S., F. G. S., F. R. S., CAN., ASSOCIATE R. S. M., AND ASSISTANT DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA. *

In a paper read before the Academy in January, 1884, and printed in the bulletin of the Academy (vol. i, No. 4), H. A. Johnson, M. D., and B. W. Thomas, F. R. M. S., gave the results of an investigation by them of microscopic organisms in the boulder clay of Chicago and vicinity. This paper refers principally to certain remarkable bodies first found by these gentlemen in 1865–6–7 in specimens of the clay through which the lake tunnel which supplies the city of Chicago with water from lake Michigan was being constructed. On the completion of the tunnel large numbers of the same bodies were observed in the filtrate from the city water supply, and which were subsequently proved to be identical with organisms described in 1871 by Sir J. W. Dawson from the Devonian shales of Kettle Point, lake Huron. They have since been observed in the Devonian rocks of a number of widely separated localities, and are now believed by Sir J. W. Dawson to be the spores of rhizocarps.† Mr. Thomas, in a note to the paper first quoted, refers to the additional discovery in boulder-clay from Minnesota, sent to him by Prof. N. H. Winchell, of several species of Foraminifera, evidently derived from the Cretaceous rocks of that region. Since this announcement Mr. Thomas has mounted for the microscope and examined many samples of boulder-clays from various places, and has favored me from time to time with

* Read before the Chicago Academy of Sciences June 9, 1885.

† Proc. A. A. A. S., 1883, and Can. "Record of Science," vol. i. See also paper by Mr. J. M. Clarke, American Journal of Science, vol. xxix, p. 284.

a number of his preparations. He has also kindly prepared and mounted specimens of several boulder-clays and allied materials collected in Manitoba and the Saskatchewan region. At his request the notes made by me on these last and on a few of those first mentioned are here offered. This paper must, however, be understood to be merely of a preliminary and general character, being based on the examination of less than one hundred microscopic preparations. It may, it is hoped, be supplemented later by a more detailed report, including the discussion of a larger suite of specimens from a greater number of localities.

The minute investigation of these boulder-clays has resulted in the discovery of many objects which, while evidently of organic origin, are very difficult to name or classify, and require comparison with a wide range of bodies and reference to many works for that purpose. Mr. Thomas has also found that even in the case of those clays with which he is most familiar each new lot of preparations mounted is almost sure to show forms not before observed, and that the field is an ever-widening one.

It is now, therefore, proposed merely to denote the classes of objects so far observed in the various boulder-clays, and when possible the genera to which the organisms belong, without attempting to catalogue them specifically. Neither is it here intended to enter into any further discussion as to the nature of the Sporangites occurring in some of the clays.

It should also be stated that most of the objects on the many slips examined have been indicated by maltwood markings by Mr. Thomas, a circumstance greatly reducing the amount of labor involved in going over the material.

[It should be explained that the material referred to in the succeeding notes is that part of the boulder-clay which is composed of particles of medium size, from which the very fine matter has, as a rule, been separated by decantation. This again has been sized by repeated decantations at intervals of one, two, or three minutes. Mr. Thomas states that the greater number of examples of a given form are frequently thus obtained in material of a certain grade of fineness.]

Boulder-clays of Chicago and vicinity.

The preparations examined representing the boulder-clay of Chicago and vicinity are as follows: From Chicago lake tunnel, 86 feet down, 5 slides; North Chicago boulder-clay, 60 feet down, 11; North Chicago clay, 64 feet down, 2; North Chicago, 65 feet

down, 10; corner of Washington and Clark streets, 8 feet down, 1; or 29 in all. These are so similar in their general characters and the class of objects which they present that they may be considered together.

The inorganic material in these clays, as represented by the above preparations, consists largely of quartz sand, in which few well-rounded grains appear, most being sub-angular and many quite angular and unworn. With these is about the usual proportion of bottle-green particles of hornblende, with a few of mica and feldspar. Nearly one-half of the entire material is, however, composed of flattened and rounded grains of fine shale, which have a dark brown color and granular texture by transmitted light. One or two of the quartz grains show included crystals and many hold fluid or gas cavities. The bodies of organic origin most commonly met with are referable to *Sporangites huronensis*, of Sir J. W. Dawson, of the Devonian shales. These are extremely abundant, and the shale particles already described are doubtless derived from the disintegration of the same beds. They are in some instances very well preserved, but are also present in all stages of decay, and in many cases hold a quantity of granular, shaly, or clayey matter in their interiors. Besides these a specimen occurs in the material from the lake tunnel of entirely different character. It is a partly flattened sphere of 0.2 m. m. in diameter, with radiating and concentric structure, brownish color, and very small central cavity, or nucleus. This is precisely similar to the bodies from the Devonian rocks described and figured as Macrospores by Mr. Clarke in his paper above referred to. Two more bodies of the same class appear in other preparations, but are more nearly transparent, and evidently in a different state of preservation. To one of them a small fragment of the matrix attaches and serves to show that both of these may have come from a limestone bed.

Next in abundance to the Sporangites is a class of bodies the true nature of which is very doubtful. Of these at least twelve large fragments were noted in the preparations under discussion, with many smaller and less characteristic pieces. They may be described as spines or spicules, generally cylindrical, but sometimes trough-shaped or triangular in cross-section, averaging about .05 m. m. in diameter, and of pale yellowish brown color. Their structure is very finely granular, and the outer surface more or less roughened, as though from erosion. They

are in some cases distinctly tubular, with a small central cavity; in others have a thick medullar portion, which is poorly defined but differs somewhat in texture from the exterior. Some of the fragments terminate in acute points, others have a slightly swollen, rounded end, and one was observed to be doubly terminated and nearly spindle shaped. They appear to be calcareous, but whether this is their original condition or the result of mineralization is uncertain. They can scarcely be chitinous, being much paler in color than other specimens of this character met with in some of the preparations. So many organisms may have produced spines or spicules resembling these bodies that it is not yet possible to assign them definitely. They do not appear to be sponge spicules, but as their color and texture is not unlike that of the next class of objects, they may possibly be partly mineralized chitinous setæ of Annelids, derived from some of the subjacent rocks. Their diversity in shape is such that they must either represent several species or belong to different parts of some organism in connection with which several types of appendage of this character are developed. See Fig. 12.

Among the most interesting bodies found in these clays are certain comblike objects which are regarded as annelid jaws. Of these four, all fragmentary, have been observed. They were at first supposed to be teeth from the lingual ribbon of some mollusk, but on more careful examination were found to be unlike the teeth of any mollusk of which figures can be found, and, moreover, to correspond almost exactly in form with some of the annelid jaws described by Mr. G. J. Hinde from the Silurian and Devonian rocks of Canada.* See Fig. 13.

One of the specimens shows a series of long and curved prongs. Three others apparently belong to a single type, in which a nearly flat plate is armed along one edge by a series of small, close denticles arranged somewhat obliquely to the line of attachment. See Fig. 14. Like the bodies last described they are of a pale straw color, differing in this respect from Mr. Hinde's specimens, which are said to be shining and black; but this difference may arise from the mode of preservation. They exhibit no reaction with polarized light, and are smooth and not distinctly granular. The ends of the prongs or denticles are worn and roughened as though by use.

Other bodies occurring in these preparations in smaller numbers need not be referred to in detail. Two broken specimens

* Quarterly Journal of the Geological Society, 1879, p. 370.

evidently represent Ostracoda. They show no well marked sculpture, but a minutely granular structure. The most perfect is .31 m. m. in length. A third specimen, somewhat larger, and also broken, is either a small Sphærium or a very young specimen of some larger shell. All three have adhering to them brownish shaly particles, which appear to indicate their origin, though it must be remarked that the shell substance is very well preserved and fresh looking. Still another specimen is a broken piece of the edge of a large calcareous shell or carapace, beautifully marked, and possibly that of an ostracod of another species. The remaining objects observed are mere fragments, quite indeterminate in character. Among these are small pieces of a delicate ribbed shell, the ribs being square in cross-section. A rather large chitinous fragment, striated extremely, but without any other apparent structure, and one or more pieces of straight tubular siliceous spicules, probably belonging to some sponge.

The probable sources of the organic bodies in these clays is discussed subsequently in connection with those from other places.

Boulder-clays from Bloomington, Ill., 107 *feet down.*

[This clay immediately underlies an interglacial deposit of soil and peaty matter with remains of wood, etc.]* Of this clay five preparations only have been examined. The coarse material is here chiefly quartz sand, of which by far the larger proportion is sub-angular. There are also a few grains of amethystine quartz, showing sharp conchoidal fracture. Several quartz grains show inclusions, one of verysmall hexagonal red crystals, probably hematite. Hornblende grains are moderately abundant, but shaly fragments such as those which make up a large proportion of the material from the Chicago clays are almost or altogether wanting. A few Sporangites exactly like those previously noticed occur, together with one or two specimens of the pale brownish granular spines, or setæ, found in the Chicago clays. A small, flat, curved, finely ribbed body in one of the slips resembles part of the edge of a carapace. While therefore not altogether wanting in this clay, organic traces appear to be very scantily represented.

* This stratum of soil is about 6 feet thick, and underlies 101 feet of boulder-clay. I do not know the thickness of the clay deposit below the inter-glacial soil.—B. W. T.

Boulder-clays from Meeker county, Minnesota.

This material is derived from a well shaft sunk in Meeker county, at a depth of about twenty-two feet, and was transmitted to Mr. Thomas by Prof. N. H. Winchell, state geologist of Minnesota. Mr. Thomas has made a large series of preparations from it, a number of which I have had the opportunity of inspecting.

As the Foraminifera contained in these preparations are being named and catalogued by Messrs. A. Woodward and B. W. Thomas, the remarks here given are confined entirely to the general character and contents of the clay, with the object of comparing it with those from other localities.

The coarser material from this clay, as it appears in the preparations, is chiefly quartz sand, which is generally sub-angular, though with some well-rounded grains. Hornblende and mica appear in about the usual proportions, and two quartz grains with very beautiful inclusions were noticed, one being probably either hornblende or rutile, the other possibly apatite. A large proportion of the material, however, consists of rounded grains of shale, of gray or greenish-gray color by transmitted light, and not nearly so dark as the shale mixed with the Chicago clays. In specimens boiled in nitric acid, the shaly fragments have become reddish from the oxidation of the iron.

Of organic bodies present in these specimens of Minnesota clay, the Foraminifera are most prominent and important. They are evidently derived from the Cretaceous strata, and resemble those found in the western development of these rocks, both specifically and in mode of preservation.

Ratalidæ and *Textularidæ* are most abundant, though specimens of *Globigerina* and other genera also occur. Next in abundance to the Foraminifera are remains of Radiolaria. Some difficulty was experienced in deciding the true nature of fragments of these bodies at first met with, but the subsequent discovery of numerous and often well preserved specimens, and the observation by Mr. Thomas that they resist boiling in nitric acid, now leaves no doubt as to their character. Several genera and quite a number of species are represented, and it will eventually be possible to determine many of these forms specifically. Most appear to belong to the Polysphæridæ and Cystidæ of Haeckel's classification. The constant occurrence of these bodies with the Cretaceous Foraminifera in the Minnesota preparations and in those from

other places, with their absence from these materials not equally characterized by the Foraminifera, leaves little room to doubt the common origin of both. Among miscellaneous objects from the Minnesota clay may be mentioned a few fragments apparently identical with the minutely granular spines or setæ described as occurring in the Chicago clays; also two broken portions of stout siliceous spicules, about .026 m. m. in diameter, one smooth, the other tuberculated; both tubular, and probably belonging to some sponge. Lastly, a single specimen of a very curious body, of straggling and irregular form, composed of numerous expansions differing in shape and size and pretty uniformly pitted, but connected by narrow, smooth necks. As this is in one of the preparations which has been treated with acid, it must be siliceous. I can only suggest that it may be the siliceous cast of some foraminifer like *Aschemonella catenata* of Norman, the arenaceous test of which has been composed of calcareous particles which have left pitted impressions on the cast. Against this is the fact of its small size, it being about .2 m. m. only in greatest diameter.

Boulder-clay from Crete, Saline county, Nebraska.

This material, Mr. Thomas informs me, was obtained from a single small excavation. It was forwarded to Mr. Thomas by Prof. G. D. Swezey, and is described by him in a letter to Mr. Thomas as a blue clay underlying the loess. The inorganic matter in the preparations made from it consists largely of fine angular and sub-angular quartz grains, with a small proportion of green hornblende and much shale or earthy limestone in little particles which differ in color and texture. It is extremely rich in organic forms, chiefly Cretaceous Foraminifera, so much so that it seems probable that it is largely composed of the debris of the Niobrara division of that formation, and that a complete study of its contents would practically include that of all the forms occurring in the chalky limestone of that stage. The present notice of it must therefore be considered as of the most general and preliminary character only. Of this material a suite of thirty-one preparations has been examined, and in an enumeration of about one hundred of the best preserved forms nearly fifty per cent belong to the *Textularidæ*, the remainder being made up in nearly equal proportions of *Globigerinidæ*, *Rotalidæ*, miscellaneous Foraminifera of other families, and radiolarians, resembling, and in some cases

identical with, the Minnesota species. Fragments of calcareous prisms from the shell of Inoceramus and in the finer matter specimens of coccoliths and rhabdoliths also occur; all resembling in every respect similar bodies found in the Niobrara rocks of Nebraska and Manitoba.*

Many of the Foraminifera are completely filled with calcite, while others are still partially hollow, and yet others are filled partly with calcite and partly with black carbonaceous or bituminous matter. Of objects of an unusual character two may be specially referred to. A rod-like body about .2 m. m. in length, narrowed near the middle, though broken at one end, and marked by numerous pits in linear series. This may be a small spine from some echinoderm. Also a hollow conical tooth or spine, evidently that of a fish, also broken, but still .25 m. m. in length.

Boulder-clay from a well at Rosenfeld, Manitoba.

This material, sent to me under the name of "hard-pan," was obtained at a depth of 135 feet, in a well bored by the Canadian Pacific railroad company at Rosenfeld, Manitoba. It formed, mixed with gravel and boulders, a layer of eighteen feet in thickness, below the post-glacial alluvial deposits of the Red river valley and resting on a Silurian shale. As the well was bored with an ordinary percussion drill, it is possible that some matter from the alluvial deposits above referred to may have been mixed with the specimen of "hard-pan," but so far as examined these alluvial deposits do not hold any organic forms. Numerous small particles of steel from the edge of the drill occur in the six preparations representing this clay.

The inorganic constituents are coarse in texture, quartz grains, of which nearly one-half are perfectly rounded, as usual predominating. Bottle-green hornblende is moderately abundant, as are also fragments of feldspar and limestone, but shaly materials are almost altogether wanting. Bodies of organic origin are rather scarce, Foraminifera, however, being most common, and a Textularia of the type of T. globulosa is characteristic. A few Rotalidæ are also present, with broken chambers of other Foraminifera. The examination of a greater quantity of the material would doubtless lead to the discovery of all the ordinary Cretaceous types.

*See a paper by the writer in the Canadian Naturalist, 1874.

Boulder-clay from the South Saskatchewan river ten miles east of the mouth of the Swift Current.

This and the two following localities in the Canadian northwest territory are represented by specimens collected by Mr. R. G. McConnell. The three localities lie between the 106th and 108th meridians, and represent a portion of the great drift-covered area of the northern plains. The material from this place is, as usual, largely siliceous, but there is a larger proportion than common of coarse, thoroughly-rounded quartz grains. Hornblende and other crystalline minerals from the Laurentian or Huronian are also present, and there is a notable quantity of amethystine quartz in angular fragments. Comminuted very fine-ground gray shale is moderately abundant. Bodies of organic origin are not frequent. In pretty carefully examining a series of six preparations, about ten only were met with. These are *Textulariæ* and rotaline Foraminifera, with one very small *Globigerina*, and a couple of radiolarians; one very perfect, oval and .09 m. m. in longest diameter. (*Haliomma?*) A fragment was also found of bony substance, showing haversian canals and probably portion of a ganoid scale. There is also in these preparations a number of rounded and flattened grains, nearly transparent, though in some cases with a more opaque central spot, and surface minutely and regularly roughened. These were eventually determined by comparison to be fragments of some pearly shell, probably that of Unio, a form quite abundantly represented in the Cretaceous and Laramie rocks of the region. The appearance of an opaque nucleus in some examples appears to result from the non-penetration of the mounting medium to the centre of the larger grains.

Boulder-clay from ten miles north of the South Saskatchewan, east of Missouri Coteau, township 21, *range* 10, *west of* 3d *principal meridian.*

The material in six preparations from this clay differs from the last described only in the much greater quantity of comminuted shaly matter of a reddish-brown tint. Bodies of organic origin are here again scarce. No Foraminifera were found. Two or three broken pieces of minute rod-like pitted objects, very doubtfully referred to small spines of some Echinoderm, and evidently identical in character with that previously described from Saline county, Nebraska, were detected. Those occurring here are

about .015 m. m. in diameter. Another somewhat similar object is rather stouter and with a roughened surface without regular markings. A small broken piece of some chitinous test was also observed, but on the whole this material is very barren.

Boulder-clay from the South Saskatchewan, fifteen miles above the Elbow.

In the preparations from this clay — eighteen in number — the sandy material is much finer than in the two last. It is nearly half composed of shaly fragments of brown color, the quartz sand being also rather more angular than usual. It is richer in organic forms than either of the other specimens from the neighborhood of the South Saskatchewan. About half a dozen specimens of Foraminifera were recognized in the preparations, one being probably a small *Discorbina*, others *Textulariæ*, and broken chambers of *Globigerinæ*. These are not so well preserved as in some of the other clays, and in some cases the shell itself appears to have been removed, leaving only a rough cast in calcite. Radiolarians are here (so far as the examination of a small quantity of material can be accepted as conclusive) even more abundant than Foraminifera; spherical, oval and turbinate forms all being represented, and in some cases in such connection with fragments of the abundant shaly material as to leave no doubt as to their common origin with it. Small, partly-rounded prisms from the shell of *Inoceramus* are also present, together with a few pieces of straight hollow siliceous spicatæ, one specimen of a minutely granular spine or seta, with a distinct medullar portion like some previously noticed, and .026 m. m. in diameter, and one of a portion of a body like that previously referred with doubt to an Echinoderm spine.

In inquiring as to the derivation of the various organic bodies in the clays, it is necessary to consider the situation of each locality with reference to known areas of the older rocks from the disintegration of which they may have come. The Sporangites so abundant in the Chicago clays have been definitely traced to the shales of the Devonian age, and have doubtless been brought to their present position from outcrops to the northward in the Michigan peninsula. It has already been stated that the bodies supposed to be Annelid jaws may probably have been derived from the same beds, or from others of the Devonian or Silurian rocks of this part of the country. With regard to the remaining bodies no definite statement can at present be returned,

though there is every reason to believe that they might very well have come from the same rocks.

In the clays from Bloomington, in the centre of the state of Illinois, Sporangites are again the most characteristic bodies, though much less numerous in correspondence with the greater distance from the shale outcrops. A few other objects associated with these are not dissimilar to those in the Chicago clays.

Meeker county, from which the specimens of Minnesota boulder-clay were derived, is in the southern and central portion of the state, and is underlaid, according to Prof. N. H. Winchell's map, by rocks of the Cambo-Silurian period.* As might be anticipated from the absence of Devonian rocks both in this locality and the whole region to the north and northeast, Sporangites have not been observed in this clay. While the greater part at least of the organisms are evidently referable to the Cretaceous rocks, the locality lies to the northeast of the generally recognized edge of that formation. Prof. Winchell has, however, proved the existence of a number of outliers of Cretaceous beyond the main area occupied by these rocks, and it is probably from one of these, possibly not remote from the actual position of the clay, that the Foraminifera and Radiolariæ have come.

The clay from Crete, Saline county, Neb., is, as already observed, so rich in Cretaceous forms as to lead to the belief that it is largely composed of the debris of the chalky limestone of the Niobrara stage, and may rest upon or lie very near to the outcrop of these beds. I am not in a position to state whether the geology of the district bears out this conclusion. The map shows at least that Cretaceous rocks underlie this part of the state.

The material from Rosenfeld, Manitoba, shows a smaller number of forms, but these are equally characteristic of the Niobrara stage, the outcrop of which, though concealed by alluvial and other deposits, can not be many miles west of the position of the well, and also runs northward along the base of the Pembina escarpment, having been recognized at a point about fifty miles northwest of Rosenfeld on the Boyne river. ("Geology and Resources of the 49th Parallel," p. 78.) As there is little probability of the existence of any Cretaceous rocks directly north or to the northeastward of this place, the occurrence of Cretaceous

* Dr. Dawson here is slightly in error as to the rocks underlying Meeker county. So far as known they are the crystalline rocks of the Archæan, probably overlain by the shales of the Cretaceous.—N. H. W.

Foraminifera would tend to show that material derived from the northwest had been incorporated with the boulder-clay of this district.

The three localities near the South Saskatchewan may be treated of together in so far as the origin of their organic constituents is concerned. The general movement of the material composing the glacial deposits of the northern plains in a southwesterly direction has already been demonstrated (see "Quarterly Journal of the Geological Society, 1875," p. 605; "Report of progress of the geological survey of Canada, 1882–4," p. 139) and it would appear that the Cretaceous Foraminifera must also have been carried from the vicinity of the eastern Cretaceous outcrops at a great distance. It is true that the clays here rest on Cretaceous beds, but these are not as a rule calcareous, or such as to yield Foraminifera in the state of preservation of these found in the clays. The Niobrara limestones are not only unknown in the entire district from which the clays come, but their place appears to be taken in this region by the Belly river beds, which are arenaceous and argillaceous. Other organic fragments present in these clays may well have been derived from the Cretaceous or Lamarie beds of the immediate neighborhood.

In reviewing the general bearings of the microscopical examination of these boulder-clays, representing as they do a few points only, scattered over a wide area in the central portion of the continent, it would be unwise to endeavor to draw any very definite or too general conclusions. The field appears to be a promising one for future inquiry, and the present paper can be regarded only as in the restricted sense, preliminary. It would appear, however, that of all the organic bodies met with none can be assigned with certainty to the glacial period or era of deposition of the boulder-clay itself. The origin of most can be traced unequivocally to the older rocks, from which they have been derived, and incorporated with the boulder-clays. Of all the bodies enumerated the only ones which, on account of their presence in clays, holding otherwise different sets of forms, may possibly be of contemporaneous origin with them, are siliceous sponge (?) *spicules* and the peculiar spines or setæ several times referred to in the foregoing. To these may be possibly added the Astracoda from the Chicago clay. While it is therefore probable that the examination of these organic fragments will serve to throw additional light on the direction of transport of material during the Glacial period — a point of particular value

over the wide area of the plains, where the soft character of the rock precludes the test of direction of striation — it has so far failed to afford any certain information as to the actual conditions prevailing during that period. The negative evidence, reinforced by the fact that derived bodies have been perfectly preserved, so far as it goes, leads to a belief in the great scarcity of contemporary life. The occurrence of inter-glacial peats and the induration of wood and other vegetable matters in the boulder-clays of a number of widely separated localities in the west (see "Vegetable remains in drift deposits of the Northwest," by Prof. N. H. Winchell, Proc. A. A. S., 1875; "Report of Progress of the Geological survey of Canada, 1882–4," p. 144) prove, however, that life was not constantly absent, and it may therefore reasonably be anticipated that further search will eventually lead to the definition in the clays of at least such contemporary organisms as may have been derived from these inter-glacial deposits, and possibly of others strictly contemporaneous with the boulder-clays themselves. The well-rounded character of a considerable proportion of the sand in some of the specimens points to prolonged water action, but there is no means of deciding to what extent in each case previously rounded sand grains have been included in the clays. The comparatively unworn appearance of the majority of the Foraminifera and other delicate objects, on the contrary, indicate rather tranquil conditions of deposit, and negatives the occurrence in the case of these materials of any extensive differential motion in the substance of the clay itself, which would infallibly have destroyed these very fragile organisms. Mr. Hugh Miller, in a carefully marked out paper on "Boulder glaciation" ("Royal physical society, Edinburgh," vol. viii, p. 157), describes a fluxion structure in the Scottish till or boulder-clay, and notes instances of sand grains so shaped and striated as to represent microscopic glaciated boulders which he conceives to have been "slidden along and glaciated in these places in the clay." No confirmation of this observation is afforded by these clays. Though many grains of an elongated shape show what might at first be taken for such striation, it is apparent in almost every case on close examination that the lines are really structural and that the shape of the grains is here, as in ordinary sands, governed to a great extent by the pre-existing cleavage or jointage planes of the material of which they are composed.

The microscopical examination of these boulder-clays bears

out the conclusion arrived at from their microscopic character, that, while largely composed of far-traveled material, they invariably contain a considerable proportion of material of local, or proximately local, origin.

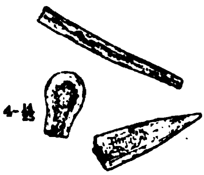


Fig. 12 (×260)


Fig. 13 (×260)


Fig. 14 (×260)

Organisms from the Chicago boulder-clays

XX.

ON THE FORAMINIFERA OF THE BOULDER-CLAY, TAKEN FROM A WELL-SHAFT 22 FEET DEEP, MEEKER COUNTY, CENTRAL MINNESOTA.

BY A. WOODWARD AND B. W. THOMAS. (JULY 1, 1885.)

[NOTE.—In the course of Mr. Thomas' investigation of the rhizocarps of the Devonian shales found in the Chicago boulder-clay, several years ago, he made a request for samples of boulder-clay from Minnesota, for comparison. About that time Mr. Dickson, living a few miles southwest from Litchfield, in Meeker county, who was sinking a common well for domestic purposes, on his farm, had found numerous fragments of Cretaceous lignite in the blue till into which he was sinking his well. These pieces attracted attention, in the public press, as indications of "coal." Thereupon Mr. Dickson, through the agency of Attorney J. N. Cross, of Minneapolis, sent me a lot of it, accompanied by a fair sample of the boulder-clay itself. This boulder-clay contained not only other pieces of lignite, but many bits of shale such as has been referred to the Cretaceous formation whenever seen in similar circumstances anywhere in the state. These were sent to Mr. Thomas. Subsequently much more shale was obtained at the same place and forwarded to Mr. Thomas. The microscopic fossils that Mr. Thomas has thus brought to light, and which are described, named and illustrated in the following paper by Messrs. Woodward and Thomas, are therefore fossils of the Cretaceous formation, and are not indigenous to the boulder-clay itself. The paper might be entitled, correctly, *The foraminifera of the Cretaceous*, since these bits of shale can be referred, without any doubt, to the Cretaceous, which is known to underlie large areas of the till in that part of the state, and since similar fossils have been found in the Cretaceous shales, *in situ*, by Dr. G. M. Dawson, in the escarpment of Pembina mountain, in Manitoba, (*Canadian Naturalist*, new series, vol. vii, p. 252). Still later a quantity of Cretaceous shale, much more calcareous, and referable to the *Niobrara*, of Meek & Hayden, was obtained at Redstone, New Ulm, through Mr. B. Juni, and sent to Mr. Thomas for a similar examination.

Through the intelligent co-operation and zeal of Mr. Thomas, united with the labor and skill of Mr. Woodward, in examining and illustrating these objects, an entirely new field of research is opened up to the geologists of Minne-

sota. Mr. Thomas has mounted all these objects for microscopic study, and has marked most of the forms on the slides with Maltwood numbers, and Mr. Woodward has drawn up the paper, which sets forth the result of their joint labor. It is to be hoped that this field may be further searched, and that a full account may finally be given of the entire microscopic fauna of the Cretaceous.— N. H. WINCHELL.]

The main object of this paper is simply to give some idea of the various forms of foraminifera to be found in the boulder-clays of Minnesota. We do not pretend that it is by any means a monograph or a perfect and complete paper, for we think from what observations we have made, and the number of species found from comparatively one or two localities, that a much fuller and more extensive paper could be written. But it cannot be done in a limited time, and it will require material from a great many localities, and several years of labor.

As it is we have been very successful, far beyond our expectations, considering the small amount of material at hand, from which we have prepared a large number of slides, selecting about eighty for this investigation, and by using a one-fifth objective we have identified the following species:

Textularia globulosa, Ehrenberg. Common.
T— agglutinans, d'Orbigny. Not common.
T— turris, d'Orbigny. Rare.
Spiroplecta Americana, Ehrenberg. Rare.
Gaudryina pupoides, d'Orbigny. Quite rare.
Bulimina pupoides, d'Orbigny. Rare.
Bolivina punctata, d'Orbigny. Rare.
Uvigerina canariensis, d'Orbigny. Rare.
Globigerina bulloides, d'Orbigny. Quite rare.
G— cretacea, d'Orbigny. Common.
G— marginata, Reuss. Quite rare.
Lagena favoso-punctata, Brady. Common.
Orbulina universa, d'Orbigny. Very common.
Operculina complanata, Defrance, sp. Rare.
O— complanata, var.
granulosa, Leymerie. Rare.

The material washed from the boulder-clays is at least 95 per cent sand, and the shells being in most cases filled solid with foreign matter, generally calcite, cannot be separated from it by drying, and scattering over distilled water, as we do recent foraminifera. Consequently it requires much work, time and

patience to secure a few good specimens of these interesting fossils.

These we have endeavored to figure and describe, giving the synonyms, and when possible using the original descriptions.

Sub-Kingdom PROTOZOA.

Class RHIZOPODA.

Order *Reticularia*.

(Foraminifera.)

TEXTULARIDÆ.

Sub-Family I.—TEXTULARINÆ.

TEXTULARIA, Defrance.

Textularia globulosa, Ehrenberg.

(Plate III, figs. 1-5.)

Textularia globulosa, EHRENBERG. Abhand. Akad. Berlin. (1838) 1839. pl. iv.
Textularia globulosa, DAWSON, 1874. Can. Nat. vol. vii, p. 253, fig. a.
Textularia globulosa, SCHARDT, 1884. Etudes Geol. Sur. le Pays—D'Enhaut. Bull, Soc, Vaud., vol. xx, p. 74.

"*T.—globulosa*, testula microscopica superficie lævi, in adulta longiore quam lata, articulis globosis." (Ehrenberg. (1838) Abhand. Akad. Berlin, p. 135.)

T.—globulosa, microscopic test with a smooth surface, adult forms longer than wide, with spherical or globular chambers.

Locality. Meeker county, Minn.

The species being generally distributed throughout the west. Is quite common in the boulder-clays of central Minnesota, also in the Cretaceous of Nebraska and Dakota.

Textularia agglutinans, d'Orbigny.

(Plate III, figs. 6, 7.)

Textularia agglutinans, D'ORBIGNY, 1839, Foram. Cuba, p. 144, pl. i, figs. 17, 18, 32-34.

Textularia agglutinans, SEGUENZA 1862, Atti dell' Accad. Gisenia, vol. xviii, (ser. 2), p. 112, pl. ii, fig. 4.

Plecanium sturi, KARRER, 1864, Sitzungsb. d. k. Ak. Wiss. Wien, vol. l, p. 704, pl. i, fig. 1.

Textularia agglutinans, PARKER and JONES, 1865, Phil. Trans., vol. clv, p. 369, pl. xv, fig. 21.

Plecanium agglutinans, REUSS, 1869, Sitzungsb. d. k. Ak. Wiss. Wien, vol. lix, p. 452, pl. i, figs. 1, 2.

Textilaria agglutinans, MOEBIUS, 1880, Foram. von Mauritius, p. 93, pl. ix, figs. 1-8.

Textularia agglutinans, BRADY, 1884, Report Foram. H. M. S. Challenger. Zool., vol. ix, p. 363, pl. xliii, figs. 1-3, vars. figs. 4, 12.

Textularia. Testa elongato-conica, rugoso-agglutinate, alba, lateraliter convexiuscula; postice cuneata; loculis largis, ultimis convexis; apertura semi-lunari. d'Orbigny (Foram. Cuba, p. 144).

Test elongate, conical, rugose, agglutinous (from grains of sand) white, laterally convex, posteriorly cuneate, segments large, the last convex, aperture semi lunate.

Locality, Meeker county, Minn.

Textularia turris, d'Orbigny.

(Plate III, fig. 8.)

Textularia turris, d'ORBIGNY, 1840, Mem. Soc. Geol. France, vol. iv, p. 46, pl. iv, figs. 27, 28.

Textularia turris, PARKER and JONES, 1863, Ann., and Mag. Nat. Hist., ser. 3, vol. xi, p. 97.

Textularia turris, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 366, pl. xliv, figs. 4, 5.

"*Textularia turris* is round in transverse section, elongate, and tapering. It differs from *Textularia trochus* chiefly in its greater proportionate length and its rougher exterior, as well as in its frequent irregularity of contour." Brady (loc. cit).

Locality, Meeker county, Minn.

We have been able so far to find but one specimen, while it

appears to be comparatively common in the Cretaceous beds of France, Bohemia, England and Ireland.

SPIROPLECTA, Ehrenberg.

Spiroplecta americana, Ehrenberg.

(Plate III, fig. 9.)

Spiroplecta americana, EHREN., 1854, Mikrogeolgie, pl. xxxii, I. figs. 13, 14; II. fig. 25.
Spiroplecta americana, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 376, pl. xlv, fig. 24, a. b.

"The test is usually much compressed, and widens rapidly towards the distal end; the lateral edges are thin and slightly lobulated, the chambers somewhat inflated, and the septal lines correspondingly depressed on the exterior; the walls are thin and smooth." Brady (loc. cit).

Locality, Meeker county, Minn.

This species does not seem to be very widely distributed.

The specimens figured by Ehrenberg were from the Cretaceous beds of Missouri and Mississippi.*

GAUDRYINA, d'Orbigny.

Gaudryina pupoides, d'Orbigny.

(Plate III, fig. 10.)

Gaudryina pupoides, D'ORBIGNY, 1840, Mem. Soc. Geol. France, vol. iv, p. 44, pl. iv, figs. 22-24.
Gaudryina pupoides, Id., 1846, Foram. Foss. Vien., p. 197, pl. xxi, figs. 34-36.
Gaudryina subglabra, GUMBEL, 1868, Abh. d. k. bayer. Akad. Wiss., II. cl., vol. x, p. 602, pl. i, fig. 4.
Gaudryina pupoides, BRADY, 1884. Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 378, pl. xlvi, figs. 1-4.

"*Gaudryina pupoides* is an easily recognised species. Its dimorphous mode of growth is generally very apparent, and its variability is limited to such features as the number of segments, the relative length and breadth of the test, and the degree of lateral compression. In recent shells the walls are thin and calcareous, smooth externally, and almost invariably of a greyish hue; fossil specimens sometimes exhibit a slightly rough exterior. In form

*Brady. *Report on the Foraminifera, H. M. S. Challenger, p.* 376.

and position the aperture resembles that of the typical *Textulariæ*, but it is often surrounded by a raised lip or borden." Brady (loc. cit.).

Locality, Meeker county, Minn.

Bulimina pupoides, d'Orbigny.

(Plate III, fig. 11.)

Bulimina pupoides, D'ORBIGNY, 1846, For. Foss. Vien., p. 185, pl. xi, figs. 11, 12.

Bulimina pupoides, WILLIAMSON, 1858, Rec. For. Gt. Br., p. 62, pl. v, figs. 124, 125.

Bulimina presli, var. pupoides, PARKER and JONES, 1862, Introd. Foram., Appendix, p. 311.

Bulimina pupoides, TERRIGI, 1880, Atti dell' Accad. Pont., ann. xxxiii, p. 193, pl. ii, figs. 30-34.

Bulimina pupoides, BRADY, 1884, Report on Foram., H. M. S. Challenger. Zool., vol. ix, pp. 400, 401, pl. l, fig. 15, a. b.

Shell oblong; obtuse, especially at the inferior lateral surface; composed of numerous segments, arranged in an indistinct spiral, and exhibiting a tendency to form three oblique vertical rows; segments remarkably ventricose and prominent; the anterior one usually more oblong than the rest, from its anterior part not being embraced, as all the preceding ones, by the next segment. Septal plane convex; semilunar. Septal orifice single, placed near the umbilical border of the septal plane, and usually characterized by a curious obliquity at its inner part, owing to the two lips of the orifice not meeting at their umbilical extremities, but passing one behind the other. Texture hyaline; transparent; when examined, after being mounted in Canada balsam, through a high power, it is seen to be perforated by innumerable minute foramina. Williamson's *Recent Foraminifera Gt., Br.* p. 62.

Locality, Meeker county, Minn.

Sub-Family 2.—BULIMINIÆ.

BOLIVINA, d'Orbigny.

Bolivina punctata, d'Orbigny.

(Plate III, fig. 12.)

Bolivina punctata, D'ORBIGNY, 1839, Foram. Amer. Merid., p. 61, pl. viii, figs. 10-12.

Bolivina antiqua, Id., 1846, Foram. Fo-s. Vien., p. 240, pl. xiv, figs. 11–13.
Grammostomum polystigma, EHRENBERG, 1854, Mikrogeologie, pl. xix, fig. 84.
Grammostomum caloglossa, EHRENBERG, Ibid. pl. xxv, figs. 17, 18.
Bolivina punctata, BRADY, 1864, Trans. Linn. Soc. Lond., vol. xxiv, p. 468, pl. xlviii, fig. 9, a, b.
Bulimina presli, var. (*Bolivina*) *punctata*, PARKER and JONES, 1865, Phil. Trans., vol. clv, p. 376, pl. xviii, fig. 74.
Bolivina elongata, HANTKA, 1875, Mittheil. Jahrb. d. k. ung. geol. Anstalt, vol. iv, p. 65, pl. vii, fig. 14.
Bolivina antiqua, TERRIGI, 1880, Atti dell' Acad. Pont., ann. xxxiii, p. 196, pl. ii, fig. 40.
Bolivina punctata, MOEBIUS, 1880, Foram von Mauritius, p. 94, pl. ix, figs. 9, 10.
Bolivina punctata, BRADY, 1884, Report on Foram. H.M.S. Challenger. Zool., vol. ix, p. 417, pl. lii, figs. 18, 19.

B. testa elongata, compressa, conica, antice obtusa, postice acuminatea, alba, punctata, lateraliter subcarinata; loculis numerosis, obliquis, undulatis, ultimo obtuso; apertura simplici. D'Orbigny (Foram. Amer. Merid., p. 63).

Test elongated, compressed, conical, obtuse, anteriorly, acuminated posteriorly, white, punctate, sub-carinate on sides, with numerous oblique undulate segments, the last obtuse, aperture simple.

Locality, Meeker county, Minn.

LAGENIDÆ.

Sub-Family 1.—LAGENINÆ.

LAGENA, Walker and Boys.

Lagena favosa-punctata, Brady.

(Plate IV, figs. 32, 33, 34, 38.)

Lagena favoso-punctata, BRADY, 1881, Quart. Journ. Mic. Sci., vol. xxi, N. S. p. 62.
Lagena favoso-punctata, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, pl. lviii, fig. 35, pl. lix, fig. 4, pl. lxi, fig. 2.

"Test ecto-or ento-solenian, shape variable; surface areolated or reticulated, with a conspicuous orifice or perforation in the middle of each area or depression. Length $\frac{1}{75}$th inch (0.34 mm.) or less." Brady (loc. cit.)

Locality, Meeker county, Minn.

Sub-Family 3.—POLYMORPHININÆ.

UVIGERINA, d'Orbigny.

Uvigerina canariensis, d'Orbigny.

(Plate IV, fig. 37.)

"*Testæ pineiformes minusculæ,*" SOLDANI, 1798, Testaceographia, vol. ii, p. 18, pl. iv, figs. E, F, G, H.

Uvigerina nodosa, var. B, D'ORBIGNY, 1826, Ann. Sci, Nat., vol. vii, p. 269, No. 3.

Uvigerina canariensis, Id. 1839, Foram. Canaries, p. 138, pl. i, figs. 25-27.

Uvigerina pinula, D'ORBIGNY, 1846, For. Foss. Vien., p. 189, pl. xi, figs. 21, 22.

Uvigerina irregularis, BRADY, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i, p. 100, pl. xii, fig. 5.

Uvigerina proboscidea, SCHWAGER, 1866, Novara-Exped., geol. Theil, vol. p. 250, pl. vii, fig. 96.

Uvigerina farinosa, HANTKEN, 1875, Mi theil. Jahrb. d. k. ung. geol. Anstalt, vol. iv, p. 62, pl. vii, fig. 6.

Uvigerina canariensis, BRADY, 1884. Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 573, pl. lxxiv, figs. 1-3.

U. testa oblongo-conica, punctata, albida; spira conica, anfractibus quinis minime convexis; loculis convexis, per quamque spiram trinis; apertura rotunda; siphone brevi. d'Orbigny. (Foraminifera Canaries, p. 138.)

Test oblong conical, punctate, whitish with a conical spire of five whorls slightly convex, segments convex, three to each whorl of the spire, aperture round, siphon short.

Locality, Meeker county, Minn.

GLOBIGERINIDÆ.

GLOBIGERINA, d'Orbigny.

Globigerina cretacea, d'Orbigny.

(Plate III, figs. 14-16. II, fig. 19.)

Globigerina cretacea, D'ORBIGNY, 1840, Mem Soc. Geol. France, vol. iv, p. 34, pl. iii, figs 12-14.

Globigerina foveolata (pars), EHRENBERG, 1854. Mikrogeologie, pl. xxiv, fig. 49.

Globigerina libani, EHRENBERG, Ibid., pl. xxv, fig. 30.

Planulina pachyderma, Id., Ibid., pl. xxv, fig. 31.

Rotalia pertusa, Id., Ibid., pl. xxiv, fig. 41.
Rotalia aspera, Id., Ibid., pl. xxvii, figs. 57, 58, pl. xxviii, fig. 42, pl. xxxi, fig. 44.
Rotalia globulosa, Id., Ibid., pl. xxvii, fig. 60, pl. xxviii, figs. 40, 41, pl. xxxi, figs. 40, 41, 43.
Rotalia densa, Id., Ibid., pl. xxvii, fig. 62.
Rotalia quaterna, Id., Ibid., pl. xxvii, fig. 53, pl. xxviii, fig. 34.
Rotalia rosa, Id., Ibid., pl. xxvii, fig. 54.
Rotalia pachyomphala, Id., Ibid., pl. xxvii, fig. 55.
Rotalia tracheotetras, Id., Ibid., pl. xxvii, fig. 35.
Rotalia perforata, Id., Ibid., pl. xxviii, fig. 36, pl. xxix, fig. 2.
Rotalia protacmœa, Id., Ibid., pl. xxviii, fig 37.
Rotalia laxa, Id., Ibid., pl. xxviii, fig 38, pl. xxix, fig. 1, pl. xxxi, fig 42.
Rotalia centralis, Id., Ibid., pl. xxviii, fig 39.
Globigerina cretacea, BRADY, 1879. Quart. Journ. Micr. Sci., vol. xix, N. S., p. 285.
Globigerina cretacea, BRADY, 1884. Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 596, pl. lxxxii. Fossil specimens, fig. 11, a -c.

"Test rotaliform, much compressed; superior face flattened or only slightly convex, inferior side depressed towards the centre and excavated at the umbilicus, periphery obtuse and lobulated; composed of about three tolerably distinct convolutions, the outer most consisting of from five to seven segments; segments relatively small, subglobular; apertures opening into an umbilical vestibule. Diameter, $\frac{1}{50}$th inch (0.5 mm.)" Brady (loc. cit.)

Locality, Meeker county, Minn.

This species is very abundant in the boulder-clays of Minnesota, but the specimens we examined were quite fragmentary; perfect examples rare.

Globigerina bulloides, d'Orbigny.

(Plate III, fig. 13.)

"*Polymorpha Tuberosa et Globulifera,*" SOLDANI, 1791, Testaceographia, vol. i, pt. 2, p. 117, pl. cxxiii, figs. H, I, O, P.
Testæ tuberosæ, etc., Id., 1798. Ibid., vol. ii, p. 20, pl. vi, figs. dd., ee.
Globigerina bulloides, D'ORBIGNY, 1826, Ann. Sci. Nat., vol. vii, p. 277, No. 1.—Modeles, No. 17 (young), and No. 76.
Globigerina bulloides, Id., 1839, Foram. Amer. Merid., p. 37.
Globigerina bulloides, Id., 1839, Foram. Canaries, p. 132, pl. ii, figs 1-3, 28.
Globigerina hirsuta, Id., Ibid., p. 133, pl. ii, figs. 4-6.
Globigerina siphonifera, Id., 1839, Foram. Cuba, p. 95, pl. iv, figs. 15-18.
Globigerina bulloides, Id., 1846, For. Foss. Vien., p. 163, pl. ix, figs. 4-6.

Globigerina concinna, REUSS, 1849, Denkschr. d. k. Akad., Wiss. Wien., vol. i, p. 373, pl. xlvii, fig. 8.
Globigerina diplostoma, Id., Ibid., p. 373, pl. xlvii, figs. 9, 10.
Globigerina depressa, EHRENBERG, 1854, Mikrogeologie, pl. xix, fig. 92.
Globigerina foveolata (pars), Id., Ibid., pl. xxii, fig. 74.
Globigerina cretæ, EHRENBERG, 1854, Mikrogeologie, pl. xxvi., fig. 44;—pl. xxx, fig. 38.
Globigerina stellata, Id., Ibid., pl. xxvi, fig. 45.
Globigerina ternata, EHRENBERG, 1854, Mikrogeologie, pl. xxxv B., figs. 5, 6.
Planulina poroteras, Id., 1854, Ibid., pl. xx, II. fig. 16.
Planulina pertusa, Id., Ibid., pl. xxii, fig. 75.
Planulina stigma, Id., Ibid., pl. xxv, fig. 29.
Rotalia rudis, Id., Ibid., pl. xxiv, figs 35, 36.
Rotalia leptospira, Id., Ibid., pl. xxiv, fig. 39.
Rotalia senaria (pars), Id., Ibid., pl, xxiv, fig. 40.
Ptygostomum orphei, Id., Ibid., pl. xxxv, B, figs. 1, 2.
Phanerostomum atlanticum, Id., Ibid., pl. xxxv, B., figs. 3, 4.
Globigerina bulloides, KUBLER and ZUINGLI, 1866, Neujahrsblatt, v. d. Burgerbib. in Winterthur, pt. 2, p. 22, pl. iii, figs. 30, 31.
Globigerina taminensis, Id., Ibid., p. 24, pl. iii, fig. 26.
Globigerina bulloides, GUMBEL, 1868, Abh. d. k. bayer. Akad. d. Wiss., II. cl, vol. x, p. 661, pl. ii, fig. 106.
Globigerina alpigena (?), Id., Ibid., p. 661, pl. ii, fig. 107.
Globigerina eocæna, Id., Ibid., p. 662, pl. ii, fig. 109.
Planulina mauryana, EHRENBERG, 1873, Abhandl. d. k. Akad. Wiss. Berlin (1872), p. 388, pl. iii, fig. 1.
Planulina globigerina, Id., Ibid., p. 388, pl. iii, fig. 3.
Planulina megalopentas, Id., Ibid., p. 388, pl. iv, fig. 7.
Pylodexia platyletras, Id., Ibid., p. 368, pl. iii, fig. 14.
Aristerospira omphalotetras, Id., Ibid., p. 388, pl. iii, fig. 15.
Globigerina detrita, TERQUEM, 1875, Anim. sur la Plage de Dunkerque, fasc. i, p. 31, pl. iv, fig. 4, a-c.
Globigerina bulloides, TERQUEM, 1875, Anim. sur la Plage de Dunkerque, fasc. i, p. 31, pl. iv, fig. 5, a. b.
Globigerina bulloides, BRADY, 1879, Quart. Journ. Micr. Sci., vol. xix, N. S., p. 71.
Globigerina bulloides, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 593, pl. lxxix, figs. 3-7.

"Test spiral, subtrochoid; superior face convex, inferior more or less convex but with deeply sunken umbilicus, periphery rounded, lobulated; adult specimens composed of about seven globose segments, of which four form the outer convolution; the apertures of the individual chambers opening independently into the umbilical vestibule. Diameter, sometimes $\frac{1}{40}$th inch (0.63 mm.), but oftener much less." Brady (loc. cit).

Locality, Meeker county, Minn.

Globigerina marginata, Reuss.

(Plate IV, figs. 20 22.)

Rosalina marginata, REUSS, 1845, Verstein. bohm, Kreid, pt. i, p. 36, pl. xiii, fig. 47.

Rosalina marginata, JONES, 1853, Ann. and Mag. Nat. Hist., ser. 2, vol. xii, p. 241, pl. ix, fig. 7.

Rosalina marginata, REUSS, 1854, Denkschr. d. k. Akad. Wiss. Wien, vol. vii, p. 69, pl. xxvi, fig. 1.

Discorbina marginata, Id., 1854, Sitzungsb. d. k. Akad. Wiss. Wien, vol. lii, p. 12, No. 2.

Globigerina marginata, PARKER and JONES, 1865, Phil. Trans., vol. clv, p.367.

Rotalia marginata, GUMBEL, 1870, Sitzungsb. d. k. bayer. Akad. Wiss., vol. ii, pp. 283, 287.

Globigerina marginata, RUESS, 1874, Das Elbethalgebirge in Sachsen, 2ter Theil, p. 112, No. 2.

Globigerina marginata, BRADY, 1879, Quart. Journ. Micr. Sci., vol. xix, N. S., p. 74.

Globigerina marginata, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 597, wood cut, fig. 17.

"Test rotaliform, much compressed; superior face convex, inferior face also convex but with a sunken umbilical recess, peripheral edge thin or subcarinate; segments numerous, five or six in the last convolution, the outer margin of each segment exhibiting a well-marked narrow border; apertures opening into the umbilical vestibule. Surface of living specimens beset with spines. Diameter, $\frac{1}{50}$th to $\frac{1}{25}$th inch (0.5 to 1 mm)." Brady (loc. cit).

Locality, Meeker county, Minn.

This species we are in some doubt about, it resembles so closely in some respects *G-linnæana*, while in others *Pulvinulina menhardii*; but the weight of evidence is in favor of *G. marginata*. Reuss.

ORBULINA, d'Orbigny.

Orbulina universa, d'Orbigny.

(Plate IV, figs. 25-31.)

"*Polymorpha Sphærule vitreæ*," SOLDANI, 1791. Testaceographia, vol. i, pt. 2, p. 116, pl. cxix, figs I-N.

Orbulina universa, D'ORBIGNY, 1839, Foram. Cuba, p. 3, pl. i, fig 1.

Orbulina universa, Id., 1839, Foram. Canaries, p. 122, pl, i, fig. 1.

Miliola (Monocystis) arcella EHRENBERG, 1854, Mikrogeologie, pl. xxx, fig. i.

Miliola sphærula, Id., Ibid., pl. xxxi, fig. 1, a. b. c.
Orbulina granulata, var. *atra*, COSTA, 1856, Atti dell' Accad. Pont., vol. vii, p. 116, pl. xi, fig. 2.
Orbulina granulata, var. *areolata*, Id., Ibid., p. 117, pl. xi, fig. 4.
Orbulina universa, Id., Ibid., p. 114, pl. xi, fig. 5.
Orbulina universa, WILLIAMSON, 1858, Rec. For. Gt. Br., p. 2, pl. 1, fig. 4.
Orbulina punctata, TERQUEM, 1862. Foram du Lias, 2ième mem., p. 432, pl. v, fig. 5.
Globigerina (*Orbulina*) *universa*, OWEN, 1867, Journal Linn. Soc., Lond., vol. ix, Zool., p. 149, pl. v, fig. 1.
Globigerina (*Orbulina*) *continens*, Id., Ibid., figs. 3, 4.
Globigerina (*Orbulina*) *acerosa*, Id., Ibid., fig 2.
Orbulina universa, BRADY, 1859, Quart. Journ. Micr. Soc., vol. xix, N. S., p. 75.
Orbulina universa, Id., 1884, Report on Foram. H. M. S. Challenger, Zool., vol. ix, p. 608, pls. lxxviii, lxxxi, figs. 8-26, pl. lxxxii, fig. 1-3.

Generic character. Shell free, regular, spherical, hollow; perforated by innumerable very minute foramina, visible only under a high magnifying power, septal orifice single, small, situate at some point on the periphery of the shell; without any marginal projection; often invisible.*

Spec. char. Spherical; parietes minutely granular, of a pale, grayish-yellow hue. Texture finely arenaceous. Septal aperture small; normally round, but usually irregular, and sometimes entirely closed up by the inspissated gelatinous sarcode, so as to be invisible. Diam. $\frac{1}{50}$—$\frac{1}{80}$.*

Locality, Meeker county, Minn.

It is a very cosmopolitan species, being found very abundantly, both living and fossil.

Several of the specimens figured by us seem to be covered with minute spines, as heretofore spoken of by other writers.

NUMMULINIDÆ.

Sub-Family 3.—NUMMULITINÆ.

OPERCULINA, d'Orbigny.

Operculina complanata, Defrance, sp.

(Plate IV, fig. 35.)

"*Operculum mimum*," PLANCUS, 1739, Conch. Min., p. 18, pl. iii, fig. 1, A. B. C.
Lenticulites complanata, DEFRANCE, 1822, Dict. Sci. Nat., vol. xxv. p. 453.

* Williamson's *Recent Foraminifera G. B.* 1857.

Lenticulites complanata, BASTEROT, 1825, Mem. Geol. Env. Bordeaux, pt. i, p. 18.
Operculina complanata, D'ORBIGNY, 1826, Ann. Sci. Nat., vol. vii, p. 281, pl. xiv, figs. 7-10, Modele, No. 80.
Operculina ammonea, LEYMERIE, 1846, Mem. Soc. Geol. France, ser. 2, vol. i, p. 359, pl. xiii, fig. 11, a. b.
Operculina complanata, RUTIMEYER, 1850, Schweizer Nummuliten—terrain, p. 108, pl. iv, fig. 56.
Operculina arabica, CARTER, 1853, Journ. Bombay Br. R. Asiatic Soc., vol. iv, p. 437, pl. xviii.
Operculina hardici, D'ARCHIAC and HAIME, 1853, Descr. Anim. Foss, du groupe nummulitique de l'Inde, p. 346, pl. xxxv, fig. 6, a. b. c.
Operculina complanata, PARKER and JONES, 1861, Ann., and Mag. Nat. Hist., ser. 3, vol. viii, p. 229.
Operculina studeri, KAUFMANN, 1867, Geol. Beschreib. des Pilatus, p. 151, pl. ix, figs. 1, 2.
Operculina marginata, Id., Ibid., p. 152, pl. ix, fig. 4.
Operculina complanata, MOEBIUS, 1880, Foram. von Mauritius, p. 104.
Operculina complanata, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 743, pl. cxii, figs. 3, 4, 5, 8.

Operculina complanata, var. granulosa, Leymerie.

(Plate II, fig. 36.)

Amphistegina fleuriausi, D'ORBIGNY, 1826, Ann. Sci. Nat., vol. vii, p. 304, No. 7 (name only), fide Reuss.
Operculina granulosa, LEYMERIE, 1846, Mem. Soc. Geol. France, ser. 2, vol. i, p. 359, pl. xiii, fig. 12, a. b.
Amphistegina fleuriausi, REUSS, 1861, Sitzungsb. d. k. Ak. Wiss. Wien, vol. xliv, p. 308, pl. i, figs. 10-12.
Operculina irregularis, REUSS, 1864, Denkschr. d. k. Acad. Wiss. Wien, vol. xxiii. p. 10, pl. i, figs. 17, 18.
Operculina granulata, GUMBEL, 1868, Abhandl. d. k. bayer. Akad. d. Wiss., II. cl., vol. x, p. 663, pl. ii, fig. 111, a. b.
Operculina var. granulosa, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 743, pl. cxii, figs. 6, 7, 9, 10.

As there seem to be some doubt and difference of opinion in regard to this species and variety, we will only undertake to give the generic description given by H. B. Brady.

The test of the typical *Operculina* is a thin complanate disk, composed of three or four broad convolutions, symmetrically arranged, and equally visible on both faces. The central portion of the disk is usually somewhat thicker than the outer whorls, and not unfrequently almost umbonate; the earlier convolutions are more or less embracing, the later whorls evolute. The segments are usually very numerous, of gradually increasing size, and typically very short in the direction of growth, as compared

PLATE I.

PAGE.

Fig. 6. *Lingula calumet*, magnified four diameters.
a, impression of the beak of the longer valve (concave). *b*, impression of the shorter valve (concave). *c*, convex surface of a small specimen. *d*, concave impression of the longer (?) valve.. 65

Fig. 7. *Paradoxides barberi*, natural size......................... 67

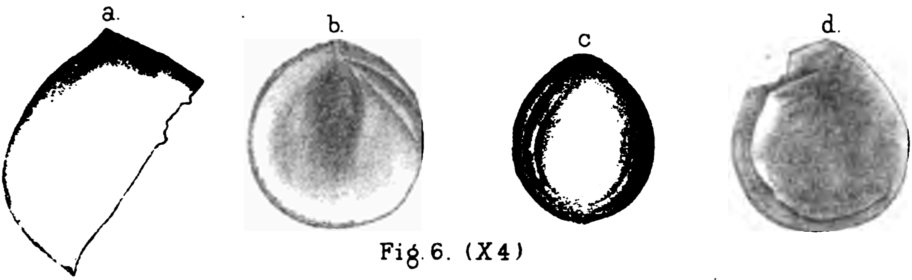
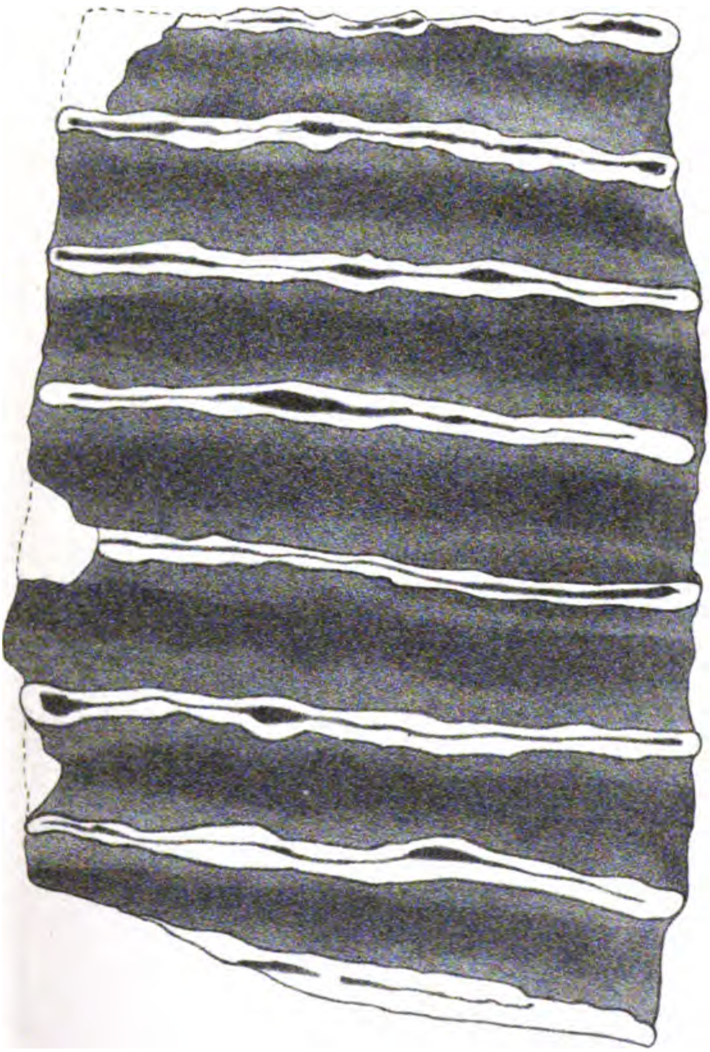


Fig. 6. (X4)

Fig. 7.

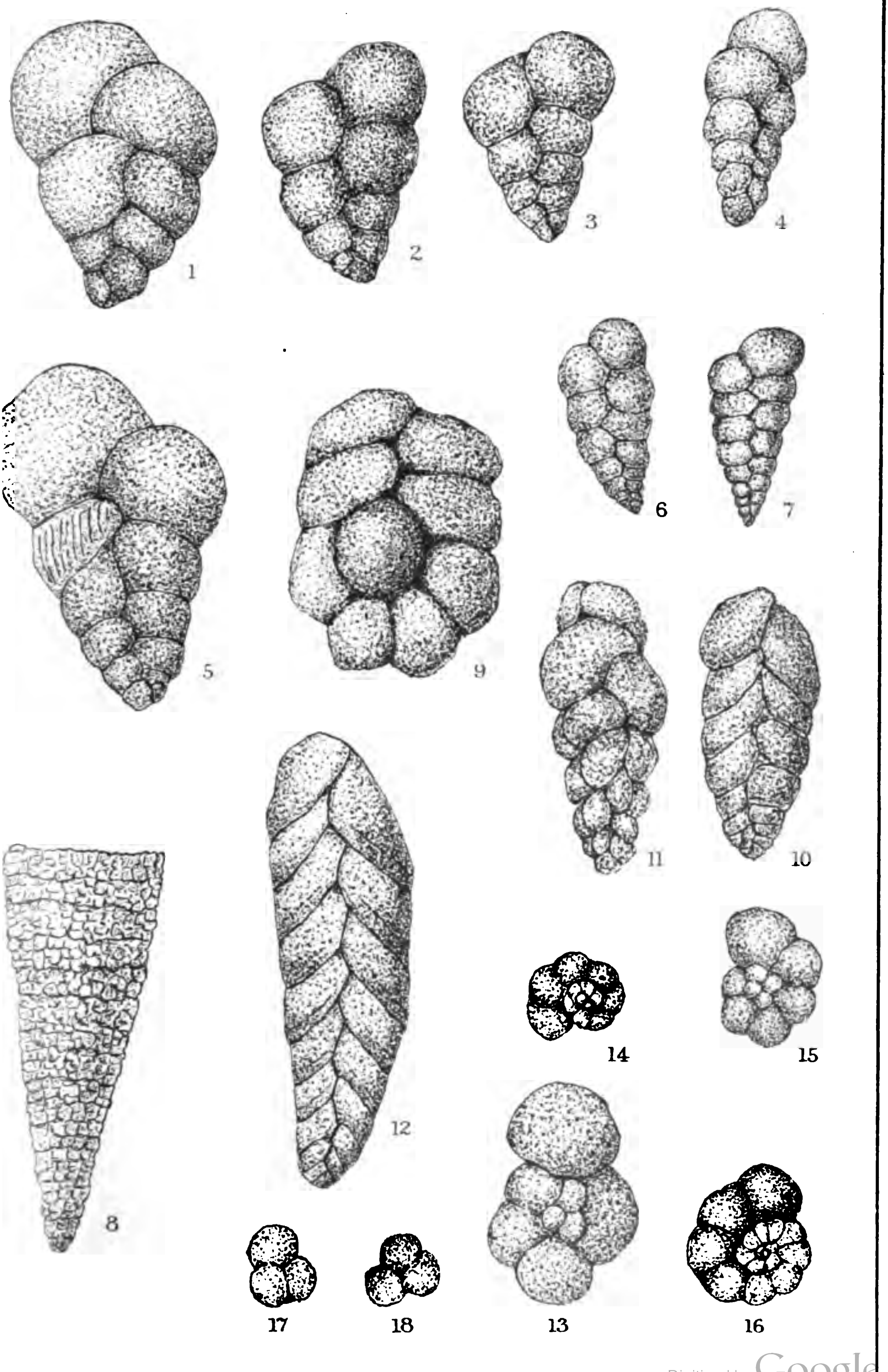
Julius Bien & Co Lith.

PLATE II.



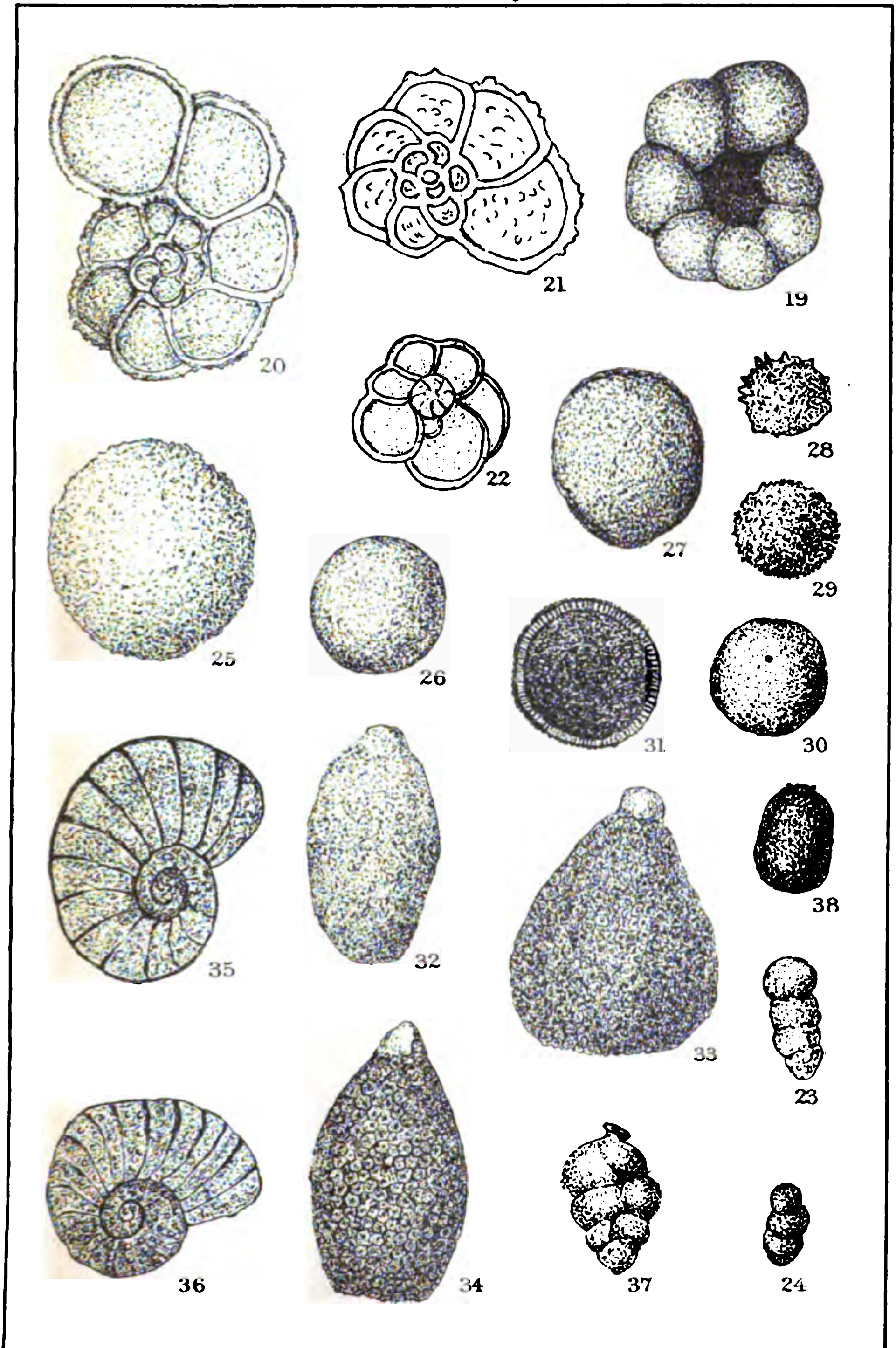
Julius Bien & Co. Lith

PLATE III.



Woodward del.

PLATE IV.



A. Woodward del.

with their width radially; they are for the most part produced on a uniform plan, but near the finish are often irregular, both as to shape and size (Pl. cxii, figs 3, 4 and 6). The exterior is sometimes smooth; but, more frequently, either the sutures or the surface of the chambers, or both, are ornamented with exogenous granules, papillæ or tubercles, which, as a rule, are more strongly developed near the centre than on the later whorls; and in the small, northern variety of the genus, the septal lines and periphery are distinctly limbate. The general aperture is a straight or slightly curved fissure at the inner margin of the final segment, close to the periphery of the previous convolution; but the test has frequently also a number of secondary orifices, in the form of small circular pores on the face of the terminal segment. The septa are double, and the skeleton is furnished with a system of canals, the general features of which are analogous to that of *Nummulites.*

Locality, Meeker county, Minn.

XXI.

NOTES ON THE MAMMALS OF BIG STONE LAKE AND VICINITY.

BY C. L. HERRICK.

The region about lakes Big Stone and Traverse is interesting not only from a geological standpoint but in its faunal relations. We here find the approximate limit of several distinct faunal areas and are not disappointed in expecting transitional forms and the material for deciding several interesting questions in systematic zoology. It is not the present purpose to anticipate the remarks which may be offered upon this subject in the final report on the *Mammals of Minnesota*, now approaching completion and which will be submitted in September, 1885; but it may be interesting to offer a few facts, which will hereafter be given more in detail, in order to secure, if possible, the co-operation of collectors in accumulating additional data. We shall find, then, in the immediate vicinity of Big Stone lake, species belonging strictly, first, to the plains of the far west, second, to the prairie region of the south and east, and third, to the woodland regions lying north and east. For example, we here find associated in seeming agreement such animals as the mole mouse of the plains, a variety of the common prairie *Vesperimus michiganensis* or Michigan mouse, the Sonora deer mouse (*Vesperimus sonoriensis*), the red-backed mouse (*Erotomys rutilus, gapperi*), the woodland *Zapus hudsonius* or jumping mouse, and, of late also, a few forerunners of the domestic mouse.

The following list embraces all the mammals at present known to inhabit the district in question, with such notes as seemed worthy of record at this time:

1. **Canis lupus,** L. Wolf.

2. **Canis latrans,** Say. Coyote.

3. **Vulpes vulgaris,** Flem. Fox.

4. **Putorius lutreolus,** Cuv. Mink.

5. **Taxidea americana,** Bd. Badger (?).

6. **Mephitis mephitica,** Shaw. Skunk.

7. **Lutra canadensis,** Sabine. Otter (?).

8. **Procyon lotor,** Storr Raccoon.

9. **Antilocapra americana,** Ord. Pronged-horned antelope.

The last occurrence of the antelope on the Minnesota side, of which I could learn, was in 1881, when one was shot six miles north of Brown's Valley, Traverse county.

10. **Vespertilio subulatus,** Say. Brown bat.

In passing over the many granitic and gneissic masses which shoulder their way through the surrounding drift in the immediate valley of the Minnesota river a few miles below Ortonville, the ear is constantly filled with an uneasy clatter, shrill and tormenting in the extreme, and proceeding from numberless bats passing the day in the crevices. It is not often easy to secure specimens, for, even if the hammer dislodges fragments of rock and destroy the retreat, the inhabitants take flight at once even in bright sunshine.

11. **Scalops argentatus,** Aud. & Bach. Prairie mole (?).

12. **Sorex (cooperi,** Baird ?). Western shrew.

Shrews, which in the lack of a special study are referred to this species, are very abundant at Brown's Valley, and in winter are said to become in part domesticated, living about barns and out buildings, much as the domestic mouse (which is not yet found here) does in other places.

13. **Sciurus hudsonius,** Pallas. Red squirrel (?).

14. **Tamias striatus,** L. Chipmunk.

The ground squirrel occurs in the thickets along the lakes, but is not abundant.

15. Spermophilus tridecemlineatus, Mitch.

The striped gopher is excessively abundant and in some seasons causes great havoc in the wheat as well as corn fields. It dwells on the prairie, while the next is equally abundant whereever a denser growth of grass or trees furnishes it a suitable retreat.

16. Spermophilus franklini, Sab. Gray gopher.

This species was found in greater abundance near Brown's Valley than elsewhere in Minnesota. It is entirely without fear and will take a place at the camper's table if unmolested, partaking of fish or fowl with no manner of diffidence.

17. Geomys bursarius, Shaw. Pouched gopher.

Our most earnest endeavors have failed in securing a specimen of *Thomomys* in Minnesota, although we had reason to expect its occurrence. The Geomys of Brown's Valley and Moorhead are typically the above species.

18. Zapus hudsonius, Zim. Jumping mouse.

It was with considerable surprise that the first specimen of this species as yet seen in Minnesota was captured at Brown's Valley in an oasis of the prairie region. The specimen was so unsuspecting that it was easily taken with the bare hand, and must have long lived in undisturbed quiet on the shores of lake Traverse.

19. Mus musculus, L. Domestic mouse.

A few specimens of a very yellow mouse, otherwise resembling the common mouse, were taken on the shores of Big Stone lake.

20. Vesperimus sonoriensis, Le Conte.

With some degree of surprise all the deer mice of the region in question were found to be in size and (less distinctively) coloration identical with the Sonora mouse. Of a considerable series not one has a tail over 2.60 inches, or a hind foot over .87, while the prevailing measurement of the former is 2.40, and of the latter .70. The colors are lighter and less conspicuous than in the deer mouse, and the white parts encroach more upon the

dorsal area, while the brown portion of the tail is a narrow stripe only. Besides these differences, in the whole anterior portion the pelage is sifted over with whitish, giving it a grayish tinge.

21. Vesperimus michiganensis, Aud. & Bach.

This species, which in the eastern part of the state is not abundant, is the most common form along the upper course of the Minnesota river. It appears in a gray, almost varietal, phase quite different in appearance from the eastern examples of the same species.

22. Onychomys leucogaster, var. **pallidus,** var. n.

A variety of the mole mouse hitherto undescribed is fully treated in the note at the close of this paper.

23. Erotomys rutilus var. **gapperi,** Vigors.

The red-backed mouse is by no means rare in the copses about the lakes and along the Minnesota river.

[24-25. Both *Arvicola austerus*, Le C., and *Synaptomys cooperi*, Bd., must be found in the region mentioned, or not far from it, but no examples have as yet been found in Minnesota.]

26. Fiber zibethicus, L. Muskrat.

The musquash is nowhere more common than in the prairie pools of the southwest. Were the fur of more than a nominal value the trapper would find profitable employment here. Upon the banks of the Minnesota river well beaten trails show where the animals leave the muddy banks where their dens are made, for the swamps adjacent.

27. Lepus sylvaticus, Bach. Gray rabbit.

This species is excessively abundant in the low ground along the upper Minnesota.

28. Lepus campestris, Bach. Prairie hare.

Quite common in winter, but it is seldom seen in summer. Universally called "jack rabbit."

To the above list which is necessarily only fragmentary, is appended a detailed description of *Onychomys pallidus*.

Genus Onychomys, Baird.

MOLE MICE.

This genus is of particular interest inasmuch as it contains three varieties of mice which, from their inaccessable station and secluded habits have seldom gained admittance to natural history museums, or received the attention of naturalists. This interest is enhanced by the fact that the genus is evidently very closely allied to *Vesperimus* but has developed in a direction entirely different from that group; and its species, externally and in habits, vary greatly from the deer mice. Fossorial prairie or desert animals living largely on insects might be expected to differ greatly from such saltatorial and gramnivorous animals as *Vesperimus* contains.

The mole mice are distinguished from their relatives by the compact arvicoline form, short tail and hind legs, well developed anterior extremities with fossorial claws, and the soft, mole-like character of the pelage. The hasty observer would refer the animal to *Arvicolinæ* rather than to the sigmodont *Murinæ;* indeed Prince Maximilian, who was the first to meet the genus, referred the *O. leucogaster* to *Hypudæus*. As we have specimens of none of the genus except *O. leucogaster*, var. *pallidus*, the reader is referred to the discussion of that variety for a description of the anatomical peculiarities. It seems that in view of the many points of divergence in structure and habits, there should be no hesitation in separating the mole mice generically from the *Hesperomys*.

Onychomys leucogaster, Maximilian. Missouri Mole mouse.

Hypudæus leucogaster, MAXIMILIAN, Reise in das Innere Nord America, 1841.
Mus missouriensis, AUDUBON and BACHMAN, Quad. N. A., 1851.
Hesperomys (*Onychomys*) *leucogaster*, BAIRD, Mam. N. A., 1857.
COUES, Proc. Acad. N. S. Phila., 1874; Monogr. N. A. Rodentia, 1877.
Hesperomys leucogaster, MAXIMILIAN, Arch. f. Naturg. xviii, 1862.

The single species thus far found under the genus *Onychomys* has differentiated into three more or less distinct geographical races or varieties. Of these but one is found in Minnesota, and that only upon the western boundary and a very short distance east of it.

The typical form is stated to be restricted to the upper Missouri river region, and is described as follows:

"Color above, grayish-brown, passing into yellowish-red, and

finally into a stripe of fulvous on the sides. Feet, including outer surface of the fore-arm and under surface of the body and tail, white."—*Baird.*

"Beneath, snow-white; above, mouse-brown, with darker dorsal area. Tail twice the hind foot or less; much less than half the head and body. Fore foot more than half the hind foot. Ear about .50 high."—*Coues.*

"The chief distinguishing feature in coloration, as compared with *Hesperomys leucopus*, is the mostly white muzzle."—*Coues.*

The following measurements from No. 7,492, of the National Museum, are selected as fairly illustrating the proportions. Nose to tail, 4.25; tail, 1.65; hind foot, .88; fore foot, .50; nose to eye, .60; nose to ear, 1.00; ear, .50. The skull of a somewhat smaller specimen measured 1.07 (Coues).

Onychomys leucogaster, var. torridus, Coues,

Was founded upon a single alcoholic specimen from Arizona, which differs in having rather larger ears and tail, and smaller fore feet. The colors are warmer. The following is Dr. Coues' diagnosis:

"Beneath, tawny-white (?); above, brownish-fulvous, with no darker dorsal area. Tail about two and a half times the hind foot; almost half as long as head and body. Fore foot half the hind foot. Ear about .75 high."—*Coues.*

Without discussing the characters on which this variety is founded, we may remark that in the only form which we have seen the proportional length of the tail and limbs was found to be subject to considerable variation, and that even while the exact pattern of coloration was maintained. Coues gives the following measurements of the specimen described: "Nose to tail, 3.75; tail, 2.00; hind foot, .80; fore foot, .40; nose to eye, .50; nose to ear, .95; ear, .70.

Onychomys leucogaster, var. pallidus, var. n.

This variety is based upon a series collected near the sources of the Minnesota river and the Bois des Sioux river in Dakota, which differs so completely in coloration from either of the above varieties as to be entirely incompatible with any description as yet given of O. leucogaster; while, at the same time, preserving the essential characters of the species. Upon first encountering the form while encamped on the shores of lake Traverse, the

writer was at a loss to classify his find, for, in coloration and form, it entirely differed from any description or figure known to him. It was at once set down as an Arvicola on the strength of its compact, obtuse form and burrowing habit, although the large ears and a certain vague suggestion in the appearance, hinted at *Hesperomys*. It was necessary to examine the teeth before conviction was reached that we had to do with a hesperomoid type. The mole-like appearance and habit at last furnished memory with the clue, and we recognized our capture as *Onychomys*.

It will be most satisfactory to transcribe the description made in our diary from the recently killed specimen as being quite unprejudiced by thought of comparison with other species.

Description of No. 103, collected July 4, 1885.

"Color nowhere other than black and white or a mixture of the two. Base of fur everywhere ashy gray. Above, black and white most intimately mixed so as to produce the effect of a whitish reflection from black fur, thus resembling a mole. On the sides the white tips are more numerous among the hairs so that the color is lighter, but the fur is so fine that the pelage would not be called grizzled. Under parts very pure delicate white (soft looking) but sparsely sown with the black-tipped hairs. Soles hairy. Tail not distinctly bi-color."

There is a dark ring about the eyes, the white of the lower parts embraces the lips to the nostrils and the muzzle is hoary. The lip is cleft and the fur about this cleft is long and hangs over like a moustache. The fur is close and dense about the small nasal pads. The insides and veins of the ears are silvery white.

The tail is terete and very closely hairy except at the tip which is as naked as in *Geomys*, and is gradually reduced in size from the middle to the apex. The vibrissæ are unusually fine and long, reaching beyond the apex of the ear and are of uncertain color, really black, but so polished as to appear partly white. The sole is very densely covered with fine close hairs, and there are but four tubercles. The ears vary in length, but seem to be intermediate between the varieties above mentioned.

O. pallidus burrows on the sandy prairies and seems to be largely diurnal in habit. We know little regarding its habits, but, inasmuch as its stomach was found filled with the remains of grasshoppers and other insects, we are justified in claiming that the suggestion of a largely insectiorous diet offered by the dentition is borne out by actual observation. The coloration

must be influenced by the constant exposure which a chase of diurnal insects makes necessary upon the open plains; and the short and nearly naked tail are suggestive of the fossorial habits.

The following table gives all the details at command concerning the proportions; and, as all the measurements were made with great care upon recently killed specimens, may be trusted as thoroughly reliable.

No.	Nose to anus.	Tail.	Nose to ear.	Nose to eye.	Hind foot.	Fore foot.	Ear.	Sex.
103	4.60	1.45	1.08	.60	.90	.55	.60	female.
104	4.40	1.35	1.00	.55	.90	....	.50	male.
105	3.95	1.50	1.00	.50	.80	.40	....	male.
114	4.15	1.60	.92	.50	.85	....	....	male.
115	5.10	1.60	1.20	.60	.90	.50	....	male.

Osteology of Onychomys pallidus. (No. 105.)

We shall present our material in the form of a comparison of the skeleton with that of *V. leucopus* as the most typical and readily obtainable example of *Vesperimus*. While much resembling that of *V. leucopus*, the skull is heavier and less slender. The facial portion, particularly, is shorter and blunter. The cranial portion is more capacious and shows a greater development of the parietals. Greatest length, 1.40; width, .58; width across parietals, .53; length of nasals, .37; frontals, .31; parietals, .18. The nasals project less beyond the incisors. The prepalatine foramen is much wider than in *V. leucopus*. The molars are larger than in any *Vesperimus*, although the third pair are more diminutive than in the actually smaller *V. leucopus*. The teeth are peculiar, especially for their very sharp-pointed angular prominences, which project out far from the crown of the tooth. The pattern is the same, but the appearance presented is very different. The basis cranii is broader, while the proportion of the parts is otherwise scarcely different. Length of basi-occipital, .16; molar series, 17; width of foramen magnum, .20. The lower jaw is chiefly remarkable for the great development of the coronoid process, which in *Vesperimus* is a minute hook, but here is large and strongly curved, extending nearly as far backward as the condyloid. The angle of the mandible is as in *Vesperimus*.

There are seven cervical, thirteen dorsal, six lumbar, three

24

sacral, and seventeen caudal vertebræ—forty-six in all. The caudal series measures 1.75, the sacral .36, the lumbar .70, and the dorsal about .90. The scapula is larger in proportion, in harmony with the greater development of the arm in general, but has the same form. Length, .54; width, .26. The humerus is .55 long, and is proportionately much heavier than in *Vesperimus*, but the superiority is more clearly seen in the forearm. The radius is .53 long, while the olecranon process of the ulnar is unusually strong. A general heaviness characterizes the bones of the hand. The hind limb is remarkable for the heavy and short bones composing it. The femur is .70 long, the tibia .75, and the longest metatarsal .30, while in *V. leucopus* these parts measure .60, .80 and .35. In this species only .30 of the fibula is united with the tibia, while in *V. leucopus* nearly .40 of its length is fused. We find, therefore, only a circumstantial confirmation of the view gained by external examination.

NOTE.—Measurements all in inches and decimals.

ERRATA FOR THE GEOLOGICAL REPORT.

Page 66, fifth line from bottom, for *two* read *four*.
Page 71, the first line should be transferred to the bottom of the page.
Page 149, fourteenth line, before *Leidy* insert *to*.
Page 171, seventh line from the bottom, for II read IV.
Page 176, twenty-first line, for II read IV.

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THE

GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

THE FOURTEENTH ANNUAL REPORT

FOR THE YEAR 1885

N. H. WINCHELL, State Geologist.

Submitted to the President of the University, March 1st, 1886.

ST PAUL:
J. W. CUNNINGHAM & CO.,
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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN., MARCH 1, 1886.

To the President of the University:

DEAR SIR:—The fourteenth annual report of progress of the geological and natural history survey of the state is hereby presented.

I have the honor to be, very respectfully,

Your obedient servant,

N. H. WINCHELL,

State geologist and curator of the general museum.

THE BOARD OF REGENTS

OF THE

UNIVERSITY OF MINNESOTA

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REPORT.

SUMMARY STATEMENT.

The Legislature of 1885, not only made provision for the binding of the rest of the edition of vol. i., of the final report, but enacted a general law respecting the publication of other volumes. It reads as follows:

AN ACT RELATING TO THE PUBLICATION OF THE REPORT OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF THE STATE.

Be it enacted by the Legislature of the State of Minnesota:

Section 1. The governor, the secretary of state and the state geologist are hereby created a commission for the printing and publication of the reports of the regents of the university on the geological and natural history survey of the state.

Sec. 2. It shall be their duty to supervise the printing of the final reports of said survey, and the engraving of the accompanying maps and illustrations, in such style and manner as they shall determine and judge best calculated to exhibit to the people of the state, the natural resources of the state as required by the law creating the geological and natural history survey.

Sec. 3. They shall cause to be republished in the same manner the third (3rd,) fourth (4th) and fifth (5th) reports of progress of said survey, at as early a date as practicable, in an edition of two thousand copies.

Sec. 4. The volumes of the final report of said survey, as they may be prepared by the state geologist from time to time, shall be issued in an edition of five thousand (5,000) copies each, and shall be distributed, in the name of the board of

regents of the university, under the direction of the state geologist, to scientific and educational institutions, and to individuals, as follows: To the library of each chartered college and scientific institution in Minnesota, three (3) copies each; to each normal school, three (3) copies; to the libraries of the institute for the deaf and mute, the insane asylums, the state prison, and every public library in the state not otherwise designated, one (1) copy each; to each of the offices in the capitol, one (1) copy; to each member of the board of regents, three (3) copies; to the library of the state university, two hundred (200) copies; to the Historical Society, and to the Minnesota academy of sciences, ten (10) copies each; to each newspaper published in the state, one (1) copy; to each senator and representative of the present legislature, one (1) copy; to the governor and lieutenant governor, each one (1) copy; to each assistant on the survey who has furnished manuscript or illustrations published in the report, three (3) copies; to the general office of each railroad that has furnished aid to the survey, three copies; to the library of each high school, furnishing students fitted for the freshman class of the state university, one (1) copy; to the state library of each state in the Union, one (1) copy; to each state university and each college of agriculture and mechanic arts, one (1) copy; to geologists and naturalists of Minnesota, fifty (50) copies; to the geologists and naturalists of other states, two hundred (200) copies; to other colleges and scientific institutions in the Uuited States, one hundred (100) copies; to foreign institutions and scientists, one hundred (100) copies; and to the state geologist, twenty-five (25) copies. The remainder shall be deposited in the state university, and shall be sold at such prices as the board of regents may determine, and the proceeds of such sales shall be used by said regents for the purchase of apparatus and books for the survey, and after its completion, for the departments of natural science at the state university.

Sec. 5. The expense of printing, engraving, binding and distribution of said reports shall be paid out of any moneys not otherwise appropriated, in the state treasury, on warrants of the state auditor approved by the governor and secretary of state.

Sec. 6. The commissioners hereby appointed shall perform the duties herein designated without further compensation than the payment of the actual expenses incurred in the discharge thereof.

Sec. 7. This act shall take effect and be in force from and after its passage.

Approved March 7, 1885.

The Legislature of 1885 also passed the following law transferring to the board of regents, for the survey, the indemnity lands granted by Congress.

AN ACT TO TRANSFER TO THE CUSTODY AND CONTROL OF THE BOARD OF REGENTS OF THE UNIVERSITY OF MINNESOTA THE LANDS GRANTED BY CONGRESS TO THE STATE BY AN ACT ENTITLED "AN ACT GRANTING LANDS TO THE STATE OF MINNESOTA IN LIEU OF CERTAIN LANDS HERETOFORE GRANTED TO SAID STATE," APPROVED MARCH THIRD (3rd), ONE THOUSAND EIGHT HUNDRED AND SEVENTY NINE (1879) TO AUTHORIZE THE SAID BOARD TO SELL SUCH LANDS AND DISPOSE OF THE PROCEEDS OF SUCH SALES.

WHEREAS, The state lands known as state salt lands, were by an act approved March tenth (10), one thousand eight hundred and seventy three (1873), chapter one hundred and thirty three (133), general laws of one thousand eight hundred and seventy three (1873), transferred to the custody and control of the board of regents of the University of Minnesota, to be by said regents sold, and the proceeds thereof held in trust by them, and disbursed in accordance with the law ordering a geological and natural history survey of the state; and

WHEREAS, It was found that certain parcels of such state lands had been otherwise disposed of by the United States to actual settlers upon such lands, for which indemnity lands have since been granted to the state by an act of Congress approved March third (3), one thousand eight hundred and seventy nine (1879); therefore

Be it enacted by the Legislature of the State of Minnesota:

Section 1. That the lands granted by Congress to this state by an act entitled "An act granting lands to the State of Minnesota in lieu of certain lands heretofore granted to said state," approved March third (3), one thousand eight hundred and

seventy-nine (1879), be and the same are hereby transferred to the custody and control of the board of regents of the university of Minnesota, which lands the said board may sell in such amounts as they may deem most expedient and beneficial, the proceeds thereof being held in trust by them, and only disbursed in accordance with the law ordering a geological and natural history survey of the state, and the said board shall make report of their doings in the premises, as provided by law.

Sec. 2. This act shall take effect and be in force from and after its passage.

Approved Feb 24, 1885.

The same Legislature appropriated a sum of money, ($12,000) for the printing and engraving necessary for volumes 2 and 3 of the final report. Of these, volume 2 is now in press, and will probably be issued during the coming year.

On the return of the collections of the survey from the New Orleans Exposition, a great deal of labor was expended in rearranging them in the museum. The rooms are more than full. Some of the cases which were returned from New Orleans are not placed in the rooms of the museum, but are stored, empty, in the Coliseum—where also are some of the specimens, because of a lack of room. At the same time the two rooms in the basement of the University which are used for general work and laboratory purposes, are very much crowded, and the progress of every department is retarded. The museum has again outgrown its accommodations. The accompanying list again will show the accessions during the year.

During July and August Mr. E. O. Ulrich was engaged in the examination of the collections of bryozoa, accumulated since the commencement of the survey. He made a good beginning in this work, and his report on the same will be found herein. There is much still to be done before a creditable and full presentation of this interesting class of fossils can be offered for final publication.

My son, Mr. H. V. Winchell, has resumed the work of collecting and listing the data of water-power utilized in the state, which was interrupted by the death of Mr. C. M. Terry. This is carried on in connection with other office and labora-

tory work, and work in the museum, and occupies but a portion of his time.

Mr. O. W. Oestlund, formerly a student of the University, and an assistant to Prof. Porter on the experimental farm, was engaged in April last, to serve as entomologist of the survey, and has been so engaged throughout the rest of the year. At a late meeting of the horticultural society of the state he was elected state entomologist to the society. Mr. Oestlund's second report is included herewith.

Mr. U. S. Grant, a student of the University has been at work casually arranging and cataloguing the collections of the survey pertaining to recent conchology. The list of recent shells found in the accompanying museum report and notes on the specimens, were prepared by him. He has had the assistance and counsel of Prof. R. E. Call, of Iowa, and of such meager literature as may be found in the University.

Mr. Warren Upham's work on the survey was terminated last April. His contributions to the geology of the state, particularly the glacial geology, have been voluminous and valuable. He has continued the same work in Dakota, in connection with the United States geological survey. A large amount of manuscript prepared by him, pertaining to the central drift-covered counties mainly, remains to be published. It will appear, according to present plans, in the second volume of the final report. Mr. Upham's careful diligence and clear-sighted apprehension of geologic facts and principles, make him not only a valuable assistant, but a reliable investigator.

Prof. J. C. Arthur, of Geneva, N. Y., was appointed botanist of the survey by authority of the board of regents, last March, but circumstances that could not be obviated have prevented him from engaging actively in this work. It is expected, however, that this department of the natural history of the state will be vigorously prosecuted during the coming year.

The manuscript reports of Dr. P. L. Hatch, on the ornithology of the state, and of Prof. C. L. Herrick, on the mammals, though not yet tendered, are understood to be in an advanced state of preparation, and will probably be completed during the coming year. In September and October, Mr. F. L. Washburn was engaged in making observations and collections for

Dr. Hatch in the northern part of the state, and has rendered some manuscript reports on his work, which has been turned over to Dr. Hatch.

The only geological field-work done in 1885, was that performed by myself in Hennepin, Ramsey, Washington, Dakota and Goodhue counties. This was intended to complete the work in those counties, and bring to a close, practically, the survey in the central part of the state. The palæontology of the primordial, Silurian and Cretaceous strata, however, is yet to be worked out fully before the geology of this part of the state can be said to be finished. Were it not for delays and interruptions incident to the publication of work already done, the field-work could be carried at once into the northern part of the state with vigor, and the survey could be brought to a close in a few years. It is hoped, however, that notwithstanding these interruptions, it will be possible during the coming summer to resume actively the work in the northern part of the state, which was interrupted in 1879.

I

NOTES ON SOME DEEP WELLS IN MINNESOTA.

BY N. H. WINCHELL.

The West hotel well, Minneapolis. This well was drilled by Mr. W. E. Swan in the summer of 1884. Its purpose was to secure a supply of good water for the West hotel. The water stands at twenty-four feet below the surface. The well is 622 feet deep. Pumping at the rate of 300 gallons per minute, lowers the water, according to Mr. Swan, about three feet in the pipe. The first water was encountered in No. 8, a white sandrock, at 168 feet, below a bed of four feet of red shale, the same that was met, with the same result, in the well at the Washburn C mill. The point of commencement of the West hotel well is from five to ten feet higher than that of the Washburn C mill. It is in the basement area, about ten feet below the surface.

		Feet.
1. Mus. Reg. No 6072. Sand drift		18
2. Mus. Reg. No 6073. Limerock (Trenton)		10
3. Mus. Reg No. 6074. Green shales (Trenton)		10
4 Mus. Reg No. 6075. White sandrock	St. Peter Sandrock. 164 feet.	91
5. Mus. Reg. No. 6076. Yellow sandrock		30
6. Mus. Reg. No. 6077. Yellow sandrock		5
7. Red shale		4
8. Mus. Reg. No 6078. White sandrock (first water).		10
9. Mus. Reg. No. 6079. Yellow sandrock		18
10. Mus. Reg. No. 6080. Gray sandrock		6
11. Mus. Reg. No. 6081. Red quartzyte, with calcareous cement, effervescing feebly	Reddish. quartzitic and dolomitic rock 138 feet. (Shakopee, Jordan, St. Lawrence.)	32
12. Mus. Reg. No. 6082. Fine (crypto-crystalline) limestone, hard, drab siliceous		40
13. Mus. Reg. No. 6083. Red limestone, siliceous, hard, fine, verging to the drab limestone of No. 12		10
14. Limestone, with white sand intermixed, similar to No. 12, but rather yellowish-pink than drab in color		15
15. Brown-red, hard rock, a calcareous quartzyte, some of it being a fine siliceous limestone		6
16. Fine, light-pinkish limestone, with numerous white quartz grains intermixed. The drillings are nearly half sand. but Mr. Swan thinks there is no sand in this rock (No. 16) but that the sand works in from above, which is probably true		30
17. White sand (second water)	Madison(?) 96 ft.	5
18. Fine, pinkish sand, very hard		1
19. Rounded, coarse, white sand (water increased to 20)		90
20. Calcareous shale (?)	Mendota ? 162 ft.	45
21. Green shale		104
22. Hard, sub-crystalline shale, greenish. slaty		12
23. White sandstone (third water.) Dresbach sandstone (?)		80
Total depth		622

The Lakewood Cemetery well, Minneapolis. The drilling of the deep well at the Lakewood cemetery was continued to the depth of 2,118 feet. Samples of the drillings said to have come from this depth show a reddish-brown schistose or shaly rock, like much of that above in the same drill, and apparently belonging still in the Cupriferous.

The general summary of this well given on page 54, of the 13th annual report, would harmonize better with facts derived from the deep well at elevator B. St. Paul, and perhaps with others, if it were slightly modified. With this modification there is nothing in the record to interfere.

It would be as follows:

1. Drift, 1—256 feet......................................256 feet.
2. White sandrock. 256—318 feet. (St. Peter.).....................62 feet.
3. Dolomitic rock, 315—325 feet. (Shakopee.)......................10 feet.
4. Assuming that the unrepresented interval is made up of white sandstone. 325—360 feet. (Jordan.).......................35 feet.
5. Dolomitic rock, 360—403 feet. (St. Lawrence.)....................55 feet.
6. White quartz sandrock, 403—504 feet. (Madison.)..................101 feet.

&c. &c. &c.

The Hospital well, St. Peter. Through the co-operation of Dr. C. K. Bartlett, superintendent of the hospital for the insane, the following record has been obtained of this well: It was drilled in the fall of 1885. This well begins at the foot of the river-bluff, not far above the level of high water of the Minnesota river. There had before been excavated here a reservoir for water and a pump-house erected for throwing the water to a higher level, for the use of the hospital. This reservoir was fed by springs issuing from the sandstone, of which the bluff is mainly composed. At the depth of 116 feet the water began to flow over the top of the pipe, which was driven into the rock to protect the drill, and rose above the ground about two feet. The flow gradually increased to the bottom of the well, which is 200 feet below the point of beginning. The water will rise in a tube seven feet above the ground, or some ten feet above the original level of the reservoir, and at least twenty-five feet above the level of low water in the river. This record is valuable, as it throws light on the stratigraphy of the upper part of the Cambrian in that part of the state. The record furnished by Dr. Bartlett is as follows:

1.	Gravel and loose rock	15 feet.
2.	Sandrock, (Jordan)	65 feet.
3.	Pink limestone. (St. Lawrence)	70 feet.
4.	Gray sandrock, hard	15 feet.
5.	Pink limestone rock	10 feet.
6.	Red sandrock	22 feet.
	Total	197 feet.

This record was very carefully kept, according to Dr. Bartlett, by the man who drilled the well. The drillings were examined by him every four feet, as the work went on. No. 2. above, is seen in the river bluff adjacent to the pump-house, and rises about twenty feet higher than the top of the well, making its total thickness about 85 feet. The rest of the bluff consists of magnesian limestone, the same that is quarried at Kasota, and continues for some distance, having a thickness of about twenty feet. It is the same as that quarried formerly at the Hospital building, and was used in its construction. It was described in the third annual report, page 143, and considered to be the Shakopee. There remains, now, some doubt whether the stone quarried at Mankato is the equivalent of this upper limestone. It seems rather to agree in thickness with the lower one.

The Mankato well, was drilled in the early part of the year 1885, but unfortunately no drillings were preserved systematically, nor any record of the boring kept as the work proceeded. From Prof. A. F. Bechdolt the following information has been derived. The well is on the land of Mr. Carstadt, one-and-a-half blocks west of the oil-well, on Third street. It is situated within the general valley of the Minnesota, and west of the strike of the limestone bluff. It is ninety-six feet deep. The clay begins at 45 feet below the surface and is 28 feet thick. Water rose to the surface at once on penetrating through this clay, and continued to increase to its maximum, which occurred at 8 feet depth in the rock under the clay. This rock, which was entered 21 feet, is described by the owner as variable in hardness, having layers that were soft about six to twelve inches thick, alternating with hard ones that were from twelve to eighteen inches thick, the last hard layer being about three feet thick.

Prof. Bechdolt sent a single sample of the drillings from the rock below the blue clay, but from no definite horizon. They are very fine, light gray in color, homogeneous, and under the magnifier appear to be mainly quartz. When magnified about fifty diameters they show distinctly that they are mainly of angular grains of translucent quartz, not at all water-worn but pitted and reticulated. They also show a few brown scales of what appears to be some organic substance. On the application of hydrochloric acid the powder foams up somewhat, but this is due to the presence of some soluble grains, the great part of the powder being inert. The grains polarize like silica. They are not like any heretofore seen in the Cambrian, but are probably from the Cretaceous and were apparently washed from a clay or shale of that age. Museum Reg. No. 6115.

The Herman well. Mr. Charles Pullman drilled a well at Herman, for the convenience of his hotel. At 150 feet he sent a sample of gray syenitic rock containing a soft, soapy, foliated, light green mineral. At the depth of 152 feet the rock is essentially the same, but the drillings are finer and rusty. Museum Register Nos. 6116 and 6117.

The Brown's Valley well. This is an artesian well, made in 1884. It is located in the valley that runs between the Big Stone and Travers lakes, about 150 feet below the general level of the prairies in that part of the state. A stream about an inch in diameter flows from this well. The first overflow was had at the depth of 420 feet and the second at 425 feet. According to Mr. J. O. Barrett the strata in this well were as follows:

1. Blue clay, growing darker and denser to....360 feet.
2. Dark carbonaceous shale, hard and heavy, Museum Register, No. 6112....2 feet.
3. Gravel and sand, alternating with layers of blue clay....58 feet.
   [At the bottom of this was the first artesian water.]
4. "Quartz rock."....5 feet.
   [Under this was the present flow of artesian water.]
5. Greenish, micaceous, kaolinic shale, or clay. Museum Register, No 6113....20 feet.
6. Rather coarse, angular quartz grains, apparently washed from the drillings. Museum Register No. 6114. These are generally white, opaque and wholly unwater-worn. They contain some olive-gray grains that appear to be made up of several smaller siliceous grains cemented, like some seen in the Tracy well....20 feet.

Total depth....465 feet.

The water flows steadily, about 225 barrels each twenty-four hours, and is said to have a pressure that would cause it to rise above the surface about 200 feet. It is soft and "soaps" profusely, and possesses certain curative qualities. The strata penetrated all pertain to the Cretaceous formation. For the chemical qualities of this water, the reader may consult the analysis of Prof. J. A. Dodge in another chapter of this report.

The Milbank well. This is at Milbank, Grant county, Dakota. The following information is given on the authority of Mr. J. W. Williams. The total depth is a little over 300 feet, but granite was struck at 283 feet, (Museum Register, No. 6125,) and was drilled into about 20 feet. The alternating strata were:

1. Blue clay....75 feet.
2. Shale....200 feet.
3. Gravel, "clamshells" and pebbles,....8 feet.
4. Granite....20 feet.

Total depth....303 feet.

The Rosenfeld Sta. well. Following is the record of this well, as given by Mr. W. E. Swan who drilled it. It is on the Canadian Pacific railway, southwestern branch, twenty miles northwest of St. Vincent. It is interesting in view of the extension of the St. Vincent salt basin so far in that direction. It was from this well that was procured the boulder-clay in which were found Cretaceous microscopic fossils as described by Dr. G. M. Dawson in the last report, p. 157.

1.	Black soil	4 feet.
2.	Blue clay	111 feet.
3.	Sand and gravel	10 feet.
4.	Hardpan, yellow	4 feet.
5.	Boulders	6 feet.
6.	Gray slate	62 feet.
7.	Yellow limerock	15 feet.
8.	Red shale	5 feet.
9.	Gray shale	10 feet.
10.	Brown shaly limestone (flow of salt water)	30 feet.
11.	Gray sand-shale	40 feet.
12.	Chalk, white	80 feet.
13.	Red shale	160 feet.
14.	Magnesian limerock (second flow of salt water)	305 feet
15.	Red shale	75 feet.
16.	Reddish sandrock	50 feet.
17.	Red shale	50 feet.
18.	Mixed red and gray shale	25 feet.
19.	Gray shale	20 feet.
20.	Red shale, quartzy	15 feet.
21.	Granite	2 feet.
	Total depth	1087 feet.

The Sleepy Eye well. This well is three miles southeast of Sleepy Eye, on the bank of the Cottonwood river. The following information is given on the authority of Mr. C. M. Phelps, who drilled the well. The granite struck at the bottom of this well is red and chloritic.

1.	Drift, (soil &c.)	28 feet.
2.	Gravel, giving water about	2 feet.
3.	Clay, without pebbles	30 feet.
4.	Gravel and sand (with water), about	2 feet.
5.	Clay like the last, (with water at 80 feet)	18 feet.
6.	Pebbly clay	100 feet.
7.	Coarse gravel, about	2 feet.
8.	"White clay," with no pebbles, containing one thin stratum of brownish red clay,	58 feet.
9.	Clay similar to the last, but of somewhat darker color	21 feet.
10.	Red granite—drilled	8 feet.
	Total depth	269 feet.

Mr. Phelps also drilled a well about four miles southwest from New Ulm, on the farm of L. Meyers. This went through "clay" about two hundred feet, and then met with a coarse sand made up of a great variety of rock-fragments, though mainly of translucent quartz. Some of the grains are rounded as completely as in some of the Cambrian sand-stones, but the most of

them are but slightly, or not at all, water-worn. Some of the quartz grains are rose-red, some are opaque-white, some are yellowish, some are from a previously granular quartzyte and contain many smaller grains, some are dark brown, some are translucent-gray, and some are of a light translucent-green. Amongst the quartz grains are also a great many that are olive-gray and opaque, like those mentioned already in No. 6 of the Brown's Valley well. The grains that are not of pure quartz, are of a dark-green to black color, and are of various kinds of hard, aphanitic rock. These dark grains constitute perhaps one-tenth part of the whole, making the mass present a pepper-and-salt aspect. The whole seems to come from the Cretaceous. Museum Register No. 6226.

The Austin deep well. The drillings from this well were presented by Mr. W. E. Swan, and were mentioned in the Museum report for 1881, page 162, with Mr. Swan's designations. The water rose to within nine feet of the surface, from a crevice which furnished water at the depth of one hundred and sixty feet. These drillings have the Mus. Reg. Nos. 4287 to 4295.

1. Black loamy soil. (4287)........ 2 feet.
2. Yellow clay, with some quartz sand; drift, (4288)........ 12 feet.
3. Drift gravel, coarse, (4289)........ 20 feet.
4. Gray, or blue, Cretaceous shale, (4290)........ 22 feet.
5. Limestone, light gray, nearly white, effervescing freely. Among these drillings are minute crinoidal beads. from one-half centimeter to one centimeter in diameter. Some of them are pentagonal, but the most are round. They have twenty-five ridges and as many grooves alternating, on each side........ 44 feet.
6. Finely arenaceous shale, light, greenish-gray, nearly white, hardly effervescing...... 16 feet.
7. These drillings indicate a limestone conglomerate, with some calcite, and a very little pyrite; the interstices between the pebbles being filled with sand, some of it being rounded white quartz. Among these drillings also are small crinoidal joints. 64 feet.
8. Light-gray, crystalline limestone, with fragments of fossils, including small crinoidal beads. Somewhat pyritiferous........ 80 feet.
9. Rounded pebble of light-gray magnesian limestone, two and one-half by three and one-half inches in diameter. This is from the depth of 160 feet, and hence from the foregoing conglomerate.

Total depth........ 260 feet.

This well seems to pass across the horizon of superposition of the Devonian on the Silurian. Some of these limestone drillings appear like the Niagara limestone, particularly No. 5, and the conglomerate suggests the horizon of the Oriskany. The "Austin rock" seems not to appear, but its place is occupied by drift and Cretaceous shale. The shale, No. 6, very much resembles that mentioned on pages 361 and 362, of vol. i. of the final report, which occurs about a mile and a half north of Grand Meadow, in this county.

[*These notes are continued in the appendix.*]

II.

LIST OF THE APHIDIDÆ OF MINNESOTA, WITH DESCRIPTIONS OF SOME NEW SPECIES.

By O. W. OESTLUND.

But few remarks will be necessary as introductory to the following list of the Aphididæ of Minnesota. The extent of territory covered is Hennepin and Ramsey counties; and the time of observation extends over the greater part of the collecting season of the present year, with some special time given to it during September and October.

From the inability to preserve specimens of this family satisfactory for study, as can be done with most of the other families of insects, I have made it a practice to take as full notes as possible of the species from living specimens as soon as found. It is from these notes that the following list has been drawn up. Probably a more prudent plan would have been to continue these notes yet for one or more seasons, in order to verify many of the observations and to be able to present a more complete list of the locality. But if allowance be made for any short-coming that will be found on account of a too limited time of observation, I think it will yet be found to contain matter that will justify its immediate presentation.

The study of this family especially presents many difficulties that can not be overcome except by patient and long extended observations over the state, with the co-operation of many observers. It is in the hope also that the following list may induce some of our naturalists and others favorably situated to aid this department by their notes and observations, as has so successfully been done in the department of botany, that as soon as possible a complete presentation can be made, not only of this family but also of others, so far as our own state is concerned.

The economical value of this study I need not here mention. Every gardener, horticulturist and farmer who has in the least observed the work of these insects, will know to what extent their injury may accrue in spite of their small size and feeble appearance. But to be able to rightly interpret the economical relation of any family or order of insects, it will first be necessary to have a full and systematic knowledge of that family, not only in regard to the species, but especially of the life histories and habits, on which to base our conclusions. Prematurely drawn conclusions and advices are too often worthless.

Not a few of our American entomologists have given considerable attention to this family, but still we are only on the threshold, as the number of species for this country, without any doubt, will be more than doubled. Among the more important works of these writers may be mentioned:

Fitch, Asa, Valuable matter will be found in many of his entomological papers.

Walsh, B. D., On the genera of Aphididæ found in the United States. (In the proceedings of the Entomological Society of Philadelphia, Dec. 1862.)

Thomas, Cyrus, Eighth report of the state entomologist on the noxious and beneficial insects of the state of Illinois, 1879. (The most comp'ete work of all the American species that we have.)

Riley C. V, and *Monell, J.*, Notes on the Aphididæ of the United States, with descriptions of species occuring west of the Mississippi. (In the bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V., No. 1, 1879.)

The systematic classification both of the species and genera found in America is still very unsatisfactory. I can offer very few or no suggestions in this line, from my knowledge of the family being too limited, and from the want of some of the more important foreign works treating of this family. The lack of literature is probably the greatest want that the frontier naturalist has to encounter. The large libraries of this country are all far off in the East, and our own are still in their infancy; it therefore often takes months if not years to procure the desired work. Some of the species on a closer study and comparison will therefore probably be found synonymous with European species, but I think it will not be in many cases, as most of them are found on plants indigenous to this country, and can be considered as native species.

In two cases have I found it expedient to erect a new genus; if valid or not future work will have to show.

In regard to the life history of the family there are two facts that I would here, as briefly as possible, call attention to. Ever since the time of Reaumer, entomologists and naturalists, in speaking of the life history of the plant-lice, have invariably had the statement to the effect that the last brood in the fall is composed of winged males and females, and that after the sexual union of these the eggs are laid by the winged females. Even entomologists of our own time have fallen into the same error, although facts to the contrary are well known; errors that too many writers fall into from quoting authors and not nature. The relation of the different forms as now known to entomologists, and which is in accordance with my own observations, I find to be as follows: The first brood, or *spring brood*, as it might well be called, is altogether composed of the apterous viviparous females, whose sole object is the multiplication of the species, or rather the growth of the colony. But as the season advances and the warm summer days have come, a different brood begins to make its appearance, composed of the winged viviparous females, and can be called the *summer brood*. These not only continue to increase the colony in the same way as the foregoing form, but in addition thereto their object is the distribution of the species, and the founding of new colonies. So far males are very rare or not to be found at all, and they have no relation to the winged viviparous females. The last brood, or *fall brood*, is composed of winged males and apterous-oviparous females, and after the sexual union of these the eggs are laid by the females for the next season. This I find to be the general rule for the family, at least for all the higher genera, and I think will give us a more correct interpretation of the different forms; although a more detailed account will show many variations and some exceptions.

A second fact is in regard to apterous males. The occurence of this form has been noticed before by some European entomologists, but the fact seems not so far to have been confirmed by our American entomologists. In the genus *Siphonophora* I have observed them in several different species, and in one (*Siphonophora frigidæ*, described in the following pages) this was the only form that could be found.

I.—Genus SIPHONOPHORA, Koch.

Head narrow and sub-quadrate.

Antennæ on distinct frontal tubercles, approximate at base: longer or at least as long as the body; third joint long, always longer than the fourth; seventh setaceous and long, sometimes longer than the third.

Eyes with a distinct tubercle; ocelli present and usually conspicuous.

Beak moderately long.

Prothorax large, smooth or transversely wrinkled; with no lateral tubercle.

Wings very long and narrow.

Legs long and slender.

Honey-tubes very long, usually extending beyond the tip of the abdomen; cylindrical, never enlarged in middle or clavate.

Style long, usually curved upwards, often compressed, falchion-shaped

Usually found in large colonies on herbaceous, or on the leaves of woody plants.

Typical American species, *Siphonophora rosæ*, Reaum.

1. Siphonophora rudbeckiæ, Fitch.

Found abundantly throughout the season on *Solidago serotina*, Ait. and *Silphium perfoliatum*, Linn.

2. Siphonophora ambrosiæ, Thomas.

Very abundant during August and September on *Ambrosia trifida*, Linn.

3. Siphonophora frigidæ, n. sp.

Habit. Found on *Artemisia frigida*, Willd. A well characterized species on account of its shining dark-green color contrasting well with the white silky color of the plant it inhabits. In size smaller than *Siphonophora rudbeckiæ*. Winged specimens of viviparous females were seen during the summer, but no description was taken of them at the time. I can only say they were quite similar to the apterous form both in color and general appearance; the venation of the wings being as usual in this genus.

Apterous form. Of a very uniform shining dark-green color, somewhat of a metallic luster. Head narrow, subquadrate; usually slightly darker than the rest of the body. Eyes black, with a small and blunt ocular tubercle. Antennæ on prominent frontal tubercles, about as long as the body; III longest, IV a little shorter, V a little shorter than IV, VI about one-third of V, VII as long as III or sometimes longer; color black, except the base of III slightly paler. Beak moderately long, reaching

second coxæ; third joint rather long and strongly pointed; color black. Legs all black with the basal half of the femora slightly paler. Abdomen rather long, widest in the middle, cylindrical (or in oviparous females with the sides slightly emarginate,) with a row of small impressed dots of black along the margin above the insertion of the honey-tubes; dorsum is often slightly tuberculated, especially in young specimens, the tubercles giving rise to short and slender hairs. Honey-tubes black, cylindrical, reaching to the tip of the abdomen, as long again as the tarsi, not smooth, but appearing as if covered by short appressed scales when seen under the microscope. Style black, greenish at base, slightly narrowed in the middle, rounded at tip, about two-thirds as long as the honey-tubes. The anal plate of oviparous females is very long and conspicuous; black, hairy. Length of body, .08; the oviparous females are somewhat larger.

Apterous males. The occurence of this form, as noticed by a few European entomologists, is still accepted with doubt. Why so few have observed this form is probably from the fact that they have been mistaken for larva or undeveloped specimens, and therefore no special attention been given to them. That the males as a rule are winged I think there is no doubt of, and the occurence of wingless must be considered as an exception. Wingless males have been observed in both of the above mentioned species, and in one or two others belonging to this genus. In the species under consideration this form seems to be the rule and not the exception. During the summer when winged specimens were observed, only oviparous females were found, no males being seen at the time. I did not look specially for them as I felt confident they would be found further on in the season, but after a most diligent search for them during September and October, when the eggs were deposited, not a single winged specimen could be found. A great number of the wingless males, described below, were taken repeatedly during this time, and taken often in congress with the wingless oviparous females, so there can be no doubt of their being fully developed individuals.

Description. General color dark reddish-brown, in this respect differing much from the uniform greenish color of the other forms. Head of the same color with the body. Antennæ as

long as the body or usually a little longer, black, except the base of III which is slightly pale; III longest, IV and V subequal, VI one-third of V, VII as long as III, or sometimes longer. Eyes with the ocular tubercle short and blunt, no ocelli. Beak reaching second coxæ, third joint rather long and pointed. Legs black, except the base of the femora, and also the tibiæ sometimes slightly paler. Abdomen longer than broad, being rather longer and narrower than usual in males; flat above, sides margined, and with a row of black impressed dots above the insertion of the honey-tubes. Honey-tubes cylindrical, black, hardly twice the length of the tarsi, and not more than reaching to the tip of the abdomen. Style about two-thirds the length of the honey-tubes, black, narrowed at base and rounded at tip. The anal plates are black; the upper rounded at end; the lower divided into two diverging lobes or projections which are cylindrical, black, and very hairy on the under surface. Length of body, .08.

The eggs of this species are laid by the oviparous females during October in very great numbers between the leaves on top of the branches. Being tucked in between the hairy leaves they soon become firmly fastened to them by the hardening of the viscid substance that covers them when first laid, and as the leaves are persistent over winter they are well protected and in the very midst of food when the larvæ hatch the following spring. When first laid they are greenish, but soon become shining black by the hardening of the outer shell on exposure. In form oblong, cylindrical, as long again as broad, rounded at both ends, very smooth and shining; length about .03.

4. Siphonophora chrysanthemi, n. sp.

Habit. Found on the flower-stalks and heads of *Bidens chrysanthemoides*, Michx. What relation this species has to the European *Aphis chrysanthemi* I can not at present say. It is probable that they may be the same.

Winged form. Head black or blackish. Eyes dark reddish-brown, with a prominent ocular tubercle; ocelli present, bordered by a ring of black. Antennæ on moderately prominent tubercles, about as long as the body or a little longer; I twice as large as

II, III longest and cicatrized, IV a little shorter and nearly smooth, V a little shorter than IV, VI about one-half of V, VII nearly or quite as long as III; color black with the base of III slightly paler. Beak reaching second coxæ and as usual. Thorax with all the lobes black. Wings hyaline, veins slender, brownish; third discoidal obsolete at base; stigmal vein not much curved, straight the greater part of its length; stigma long and narrow, pointed at both ends, forming a distinct angle at the origin of the stigmal vein, yellowish-brown in color. Legs pale except the apical half of the femora, and the tip of the tibiæ with the tarsi black. Abdomen greenish-black; honey-tubes reaching to the tip of the abdomen, cylindrical, slightly thicker at base and tip, black in color. Style about one-half as long as the honey-tubes, pale, slightly curved upwards, thickest in the middle. Length of body .10; to tip of wings .16.

Apterous form. General color greenish-black, varying to a pale greenish-brown. Eyes with ocular tubercle. Antennæ shorter than in the winged form, about one-half as long as the body, or not more than reaching to the base of the honey-tubes; III, IV and V subequal, VI shortest, VII longest; blackish except at base. Honey-tubes as in winged form, but somewhat shorter, black. Style about two-thirds the length of the honey-tubes, pale. Legs pale, with the tips of the femora and tibiæ with the tarsi black. Length of body .08 to .09; very young larvæ vary considerable in color.

5. Siphonophora granaria, Kirby.

Found on the heads of cultivated wheat and oats, but not very often or in any great numbers. Also found more sparingly on *Phalaris canariensis*, L., or canary-grass, and on *Poa annua*, L.

6. Siphonophora ludovicianæ, n. sp.

Habit. Found on *Artemisia ludoviciana*, Nutt. Size large, body covered more or less by a white powder so as to be almost of the same grayish-white color as the plant, in this respect differing much from Siphonophora frigidæ as noticed above.

Winged form. Head straight or nearly straight in front; color pale yellowish-green. Eyes rather bright red; with the ocular

tubercle; ocelli present but not very conspicuous, and not bordered by a ring of black. Antennæ longer than the body; I twice as large as II, III very long, slightly cicatrized on the basal half, IV but a little shorter, V a little shorter than IV, VI one-half of V, VII usually very long; color black except the two first and the base of III; smooth, with very few scattered hairs. Beak long, slender, sharply pointed, black at tip; lobes of the thorax concolorous with the head. Wings as usual in this genus, third discoidal obsolete at base. Legs black or blackish, except the base of femora slightly paler. Abdomen green, but more or less covered by a white powder as in wingless form. Honey-tubes reaching to tip of abdomen, slightly thicker at base and truncated at tip; color black. Style long, widest in the middle, curved upwards, yellowish. Length of body .10; to tip of wings .17.

Apterous form. Size large, color pale green, but whole body rather thickly covered by a mealy substance. Eyes bright reddish-brown, with ocular tubercle. Antennæ as long as the body or longer, black; III longest, IV and V subequal, each but a little shorter than III, VI one-half of V, VII about as long as III. Beak reaching beyond second coxæ, basal half pale, rest black. Abdomen long, slightly margined, and with a row of impressed pits along the margin. Legs blackish except the base of femora. Honey-tubes and style as in the winged form. Length of body .12.

7. Siphonophora rosæ, Reaum.

A single colony of this species was taken September 1st, on the cultivated rose.

8. Siphonophora erigeronensis, Thomas.

Very abundant throughout the season on *Erigeron canadense*, L., or Canada flea-bane.

9. Siphonophora polygoni, Walk.

What is probably this species was seen during the summer on the common knotweed. (*Polygonum persicaria, L.*)

10. Siphonophora verbenæ, Thomas.

Found rather sparingly on the underside of the leaves of our wild verbenas.

11. Siphonophora pisi, Kalt.

This species is undoubtedly one of the most common, being found on a great number of different plants, mostly of the garden, and on introduced weeds. What I consider to be the same was also taken on *Urtica gracilis*, Ait.

12. Siphonophora achyrantes, Monell.

Found on the leaves of *Amarantus albus*, L.

13. Siphonophora corydalis, n. sp.

Habit. Found on *Corydalis aurea*, Willd. This I believe is the first species found on this order of plants.

Winged form. General color pale yellowish-green, head and thorax of a deeper yellowish color than the rest of the body. Eyes bright reddish-brown, with ocular tubercle; ocelli present and bordered by a ring of black. Antennæ on conspicuous frontal tubercles, longer than the body, black or blackish, except at base where they are pale, rather smooth, the third joint slightly cicatrized at base; I very much larger than II, III long, IV but a little shorter, V a little shorter than IV, VI about one-fourth of V, VII longest, very long and setaceous. Beak moderately long and stout, reaching second coxæ, black at tip. Prothorax rather large, transversely wrinkled; mesothorax of uniform color throughout, usually of a deep yellow, as the head; the lobes smooth and shining. Wings hyaline, stigma long and narrow; stigmal vein strongly curved, the third discoidal obsolete at base. Legs long and slender, pale except at the joints and the whole of tarsi which are black. Abdomen rather long, gradually narrowed behind, greenish. Honey-tubes very long and narrow, cylindrical, reaching beyond the tip of the abdomen and almost to the tip of the very long style, pale at base, rest all black. Style very long, about two-thirds the length of the honey-tubes, greenish, thickest in the middle, slightly

curved, gradually tapering to a point. Length of body, (style not included,) .10; to the tip of wings .18 to .20. Honey-tubes about .03.

Apterous form. Body rather long and narrow. Color of a uniform pale green. Eyes rather bright red, with tubercle. Antennæ as long or longer than the body; very similar to the winged form, but usually quite pale, except at the joints and the whole of sixth black. Legs, honev-tubes and style as in the winged form. Length of body .10.

14. Siphonophora adianti, n. sp.

Habit. Found on the underside of the fronds of *Adiantum pedatum*, L. The ferns, I believe, have generally been considered as entirely exempt from the attack of plant-lice, but this species, together with a second, described further on, will show that even this order has its peculiar species. Only apterous individuals have so far been taken. They seem to be rather widely spread, but never occuring in any great numbers; usually in small groups of five or six.

Apterous form. General color bright lemon-yellow, sometimes greenish; in size rather smaller than usual in this genus. Antennæ longer than the body, black or blackish, except the frontal tubercles and the first two joints, which are of the same color with the body; III long, IV and V subequal, VI about two-thirds of V, VII as long as III, or a little longer. Eyes reddish-brown, with tubercle. Beak very short and stout, not reaching to the second coxæ, rather bluntly pointed, hairy and black at tip. Abdomen rather wide and rounded behind. Legs pale, except the tips of the tibiæ and the tarsi, which are black. Honey-tubes long and slender, reaching beyond the tip of the abdomen and about twice the length of the tarsi, pale, except tip sometimes dusky. Style about one-half the length of the honey-tubes, rather thick and conical. Length of body .06 to 07.

Eggs of this species, taken during October, were deposited on the under side of the fronds. In form cylindrical, rounded at both ends, a little longer than broad, very smooth and shining. When seen they were pale in color, but undoubtedly became black on exposure as usual in this genus.

II.—Genus MACROSIPHUM, g. nov.

Head more transverse and larger than in *Siphonophora*.
Antennæ on moderately large and not approximate frontal tubercles; longer than the body, (at least in the winged form); the third and seventh joint longest.
Eyes large and round, with a distinct tubercle; ocelli present and very conspicuous.
Beak moderately long.
Prothorax large, with a lateral tubercle.
Wings long and narrow; sometimes clouded at tip.
Legs long and slender.
Honey-tubes very long, extending far beyond the tip of the abdomen; usually much dilated in the middle and slightly curved.
Style long and conspicuous.

The species on which this genus has been founded is very similar to Kaltenbach's *Siphonophora rubi*, although apparently specifically distinct, and would therefore probably with it be included in that genus. But the dilated honey tubes, robust style, prothoracic tubercle and clouded wings (at least in the female) I think will justify a separation. What importance can be put on some of these characters I can not here discuss, but I have reason to believe that these together with other facts show a higher differentiation than even Siphonophora, and in a strictly systematic arrangement would come before that genus.

1. Macrosiphum rubicola, n. sp.

Habit. Found clustered around the tender twigs and underside of the leaves of *Rubus strigosus*, Mx. A very large and most elegant species.

Winged form. General color whitish or yellowish-white. Head transverse, straight in front, more or less dusky above. Antennæ as long as the body or often considerably longer, on moderately conspicuous frontal tubercles, not approximate at base; the frontal tubercles as well as the base of third joint whitish (sometimes the fourth and fifth joints are also pale at base), rest all black; I and II as usual in this section, III the longest, IV a little shorter, V a little shorter than IV, VI the shortest and about one-third or one-fourth of V, VII long and setaceous, often as long as III; III more or less tuberculate. Eyes large, reddish-brown, with a distinct tubercle; ocelli present and very conspicuous; bordered by a ring of black. Beak moderately long, reaching second coxæ, or slightly beyond, stout and rather hairy, whitish at base and dusky at tip. Prothorax very large, sides slightly emarginate, and with a distinct lateral tubercle,

rather robust. Lobes of mesothorax shining black above, the ventral of a dull black. Wings long and narrow; stigma very long and broad, pointed in front and behind, forming a distinct but very obtuse angle at the origin of the stigmal vein; dusky or almost black; tip of wings smoky, this clouded patch is between the third discoidal and the stigmal vein, extending partly into the stigmal cell; stigmal vein strongly curved at base, rest nearly straight. Legs long and slender, femora whitish with their tips black; tibiæ dusky with their tips, together with the tarsi, black. Abdomen longer than broad, sides parallel and but a little wider at the middle than the thorax; flat, with impressed pits along the slightly margined sides; color whitish with some green markings above, the ventral greenish-white. Honey-tubes very long, extending more than half their own length beyond the tip of the abdomen; slightly attenuated near the base, then gradually enlarging, becoming thickest above the middle, where they are at least twice as thick as at base, again more rapidly contracting near the tip, ending as usually in a flat rim. Being more strongly enlarged on one side they become slightly bent; color dusky especially at the base and tip, but transparent, the liquid globules being visible. Style cylindrical, or but slightly narrowed near the base, bent upwards, with but few hairs and of the same color with the body. In length about one-fourth the honey-tubes or about twice the length of the tarsi.

Length of body (style or honey-tubes not included) .10—.12; to the tip of the wings .18—.20.

Winged male. Found as late as November the 1st, together with the oviparous wingless females. Head transverse, considerably broader than long, black or blackish. Antennæ longer than the body, on rather prominent frontal tubercles; relative length of the joints the same as in females; all black. Eyes large and prominent, with tubercle; ocelli present, bordered by a ring of deeper black than that of the head. Beak reaching second coxæ, blackish. Prothorax well developed, as long as the head, lateral tubercle more or less obvious. Mesothorax shining black. Wings as in female, but the stigma is not so black, and the smoky patch at the tip of wings wanting. Legs all black, except the base of femora and tibiæ slightly paler. Abdomen blackish-green, short, with more or less black markings on the

dorsum. Honey-tubes very long, reaching beyond the tip of the style, sub-cylindrical, enlarged only at the very tip where they are trumpet-shape; black. Style as in females. Anal plates conspicuous, black, and very hairy, especially the lobes of the lower plate. Length of body .08; antennæ .12; to the tip of wings .20.

Apterous form. General color during summer very pale, whitish, becoming pale lemon-yellow late in the season. Head straight in front. Antennæ seem to vary much in length from much longer than the body to shorter, (especially all those examined late in the season had them shorter than the body,) the relative length of the joints as in foregoing forms; color the same with the body, with the tips of the upper joint and the whole of the sixth blackish. Eyes moderately large, dark reddish-brown with tubercle; no ocelli. Beak rather long and stout, reaching slightly beyond the second pair of coxæ, first and second joints subequal. Prothorax with a more or less obvious lateral tubercle. Abdomen long and narrow, widest at the insertion of the honey-tubes. Legs very pale, except the tips of tibiæ and the whole of tarsi, which are black. Honey-tubes as in the winged female, very pale or whitish throughout, or with the tips black, this being the case with all taken late in the season. Style shorter than in winged female, not much longer than the tarsi, cylindrical, with but few hairs, of the same color with the body.

III.—Genus MEGOURA, Buckton.

Head broad; straight in front.
Antennæ much longer than the body; frontal tubercles large; remote at base; third joint longest; second twice the size of the first; fourth longer than the fifth; seventh setaceous.
Eyes with tubercle; ocelli present.
Beak rather short.
Wings and legs as in Siphonophora.
Honey-tubes long, dilated in the middle, expanded at the end, or trumpet-mouthed.
Style markedly long and thick.
Habit sporadic.

1. Megoura solani, Thomas.

Found on the common tomato. This peculiar species is by no means rare in the gardens around Minneapolis, although never found in great numbers on any one plant.

IV.—Genus MYZUS, Pass.

Head transverse.
Antennæ on moderately large tubercles; these gibbous on the inner side, as is also the first antennal joint; about as long as the body.
Eyes with a distinct tubercle; ocelli present.
Prothorax usually with the pronotum narrowed in the middle.
Legs moderately long.
Wings very much as in Aphis.
Honey-tubes reaching to the tip of the abdomen, cylindrical, or slightly enlarged toward the apex.
Style rather short.
Habit. Mostly found on the foliage of plants belonging to the rose family; some species causing the leaves to cup and become deformed.
Typical American species, *Myzus ribis*. L.

1. Myzus cerasi, Fab.

This species seems to be found wherever the cherry is cultivated. So far as I am aware it has not shown itself specially troublesome in this state.

2. Myzus ribis, Linn.

Found plentiful on the cultivated currants, causing the leaves to curl up, forming corresponding crispy swellings above. When they become very numerous on a bush they cause the leaves to turn yellow and to drop off, as I noticed in several instances.

3. Myzus potentillæ, n. sp.

Habit. Found on the underside of the leaves of *Potentilla anserina*, Linn.

Winged form (males). General color yellowish-green. Head rather broad, slightly convex in front, black or blackish. Antennæ longer than the body, black; the third slightly pale at the very base; tubercles moderately prominent, gibbous; I gibbous, II as usual, III very long and tuberculate on the underside, IV and V subequal, each shorter than III, VI one-half or one-third of V, VII as long as III or usually longer. Eyes large, reddish-brown, with distinct tubercle; ocelli present, bordered with a ring of black. Beak reaching second coxæ, pale at base, black at tip, last joint rather sharply pointed. Prothorax with the pronotum narrowed in the middle, blackish; membrane greenish. Mesothorax yellowish with the lobes and the scutellum shining black. Legs black, with the base of the femora and tibiæ paler.

The wings as usual. One specimen examined had one of the wings very abnormal, the first discoidal being completely obsolete, the second so except a very short distance near its origin, the third discoidal with but one branch. Abdomen greenish with more or less black on the dorsum in form of transverse bands. Honey-tubes cylindrical, reaching to the end of the abdomen, or in some beyond, pale, in length about three times the tarsi. Style very short, pale except sometimes at the tip, hairy. Upper anal plate of the same color as the body, lower blackish, at least the lobes. Length of body .06, wings included .10.

Wingless form. Oblong and rather convex. General color pale green; covered with small tubercles that give rise to strongly capitate or knobed hairs. Some of these knobed hairs are also found on the front of the head, on the frontal tubercles and on the first and second joints of the antennæ. Antennæ commonly a little shorter than the body, pale, but sometimes the apical joints are dusky; III, IV and V subequal, VI one-half of V, VII about as long as III. Eyes reddish-brown, with the tubercle. Legs pale, except tips of tibiæ and the tarsi slightly dusky. Honey-tubes pale, cylindrical, about three times the length of the tarsi. Style pale, short, about as long as the tarsi. Length of body .06 to .07.

The eggs. These are laid on the underside of the leaves, and as these do not fall off but remain attached to the plant over winter they afford a very good protection, and the young larva on hatching in the spring has but a short walk to make to find the new growth. They are pale green when first laid but soon become shining black; cylindrical, very smooth, rounded at both ends.

4. Myzus malvæ, n. sp.

Habit. Found on the underside of the leaves of *Malva rotundifolia* Linn. This can not be *Siphonophora malvæ* of European authors, and I know of no Myzus ever found on this common plant.

Winged form. Head and thorax shining black; abdomen green. Head transverse, pointed in the front as in aphis. Antennæ about as long as the body, black, except base of third joint; on

distinct frontal tubercles, and these very much prolonged or gibbous on the inner side; I gibbous, II as usual, III longest, IV a little shorter, V a little shorter than IV, VI about one-half of V, VII setaceous, about as long as IV. Beak reaching second coxæ. Eyes dark reddish-brown, with prominent tubercle; ocelli present. Prothorax with the pronotum narrowed in the middle, black; membrane pale. Lobes of mesothorax shining black. Legs with the apical half of femora black, tips of tibiæ and the tarsi black, rest paler. Wings as usual in this genus. Abdomen not much longer than wide, sides rounded; color pale green with a large subquadrate patch of darker green on the dorsal side, and with a row of black spots along the margins above the insertion of the honey-tubes as in *Aphis mali*. Honey-tubes reaching to the tip of the abdomen or slightly beyond, cylindrical, or generally a little thicker towards the apex, more or less dusky, the liquid drops visible through it. Style about half as long as the honey-tubes or about as long as the tarsi, cylindrical or very slightly narrowed near the base and bent upwards, hairy. Length of body .06; to tip of wings .14.

Apterous form. General color pale-green. Antennæ about half as long as the body, not reaching to the base of the honey-tubes; pale at base, rest blackish. Eyes reddish-brown, with tubercle. Abdomen pale green, (with a middle and sometimes marginal longitudinal band of darker green); not tuberculate nor with capitate hairs. Honey-tubes and style as in winged form but usually quite pale. The frontal tubercles and first joint of the antennæ very gibbous.

V.—Genus **DREPANOSIPHUM**, Koch.

Antennæ on frontal tubercles, usually longer than the body; third and last joints longest; fourth and fifth equal.
Eyes large and with a distinct tubercle; ocelli present.
Beak short.
Prothorax with no lateral tubercle.
Wings long and narrow; marginal cell elongated towards the apex of the wing.
Legs moderately long.
Honey-tubes moderately long, enlarged beneath towards the base.
Style inconspicuous or none.
Habit sporadic.

1. Drepanosiphum acerifolii, Thomas.

This peculiar species is by no means rare on the soft maple (*Acer dasycarpum*, Ehrh.) in and around the city of Minneapolis.

VI.—RHOPALOSIPHUM, Koch.

This genus is mostly characterized by American entomologists simply as similar to *Aphis* or *Siphonophora*, but with the honey-tubes distinctly clavate. As far as our American species are concerned, this is probably one of the most difficult genera to define in the family. If we on one hand take *Rhopalosiphum rhois* as a type, we have a species that is similar to *Aphis*, and could well be put in that genus with the exception of the clavate honey-tubes; if on the other hand we take *Rhopalosiphum nabali* (described below) as a type, we have a species that could well be put in *Siphonophora* but for the distinctly clavate character of the honey-tubes. If *Rhopalosiphum ribis, Koch,* prove to be a distinct species as found on our native currant (Ribes nigrum, L.), from *Myzus ribis*, L., as found on the cultivated currant, we have still another species that shows a close relation to *Myzus*. Wherefore we have to rely almost exclusively on but one single character. Now if this clavate character of the honey-tubes prove to be constant, so that we can rely on it in all cases, the genus could well be accepted to include all the species that I have included in the following; but if this character should be found to vary, as I have reason to believe, most of the following species will have to be located in other genera.

1. Rhopalosiphum rhois, Monell.

Found rather common on the underside of the leaves of *Rhus glabra*, Linn.

2. Rhopalosiphum ribis, Koch.

Found on the underside of the leaves of wild currant (*Ribes nigrum, Linn.*), and as far as I observed not causing the leaves to cup as in the case with *Myzus ribis*, Linn., found on the cultivated currant. It is probably but a variety of this last named

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species, though the honey-tubes are distinctly clavate and would locate it here.

3. Rhopalosiphum sonchi n. sp.

Found on *Sonchus asper*, Vill.

Winged form. Head transverse, straight in front, or but slightly convex, more or less black above. Antennæ about as long as the body, black except the base of the third joint slightly paler, on rather small frontal tubercles, and these somewhat gibbous or enlarged on the inner side; I much larger than II, III long, IV a little shorter, V a little shorter than IV, VI about one-third of V, VII as long as III or often very short; III and IV are strongly tuberculated and cicatrized, especially on the under side. Eyes large, reddish-brown, with a distinct tubercle; ocelli present and conspicuous as a glassy point bordered by black. Beak as usual, reaching second coxæ, pale except at tip. Prothorax with the pronotum narrowed in the middle, black; membrane greenish. Lobes of mesothorax all shining black. Wings hyaline; costal veins yellowish, the rest brownish; third discoidal obsolete at base. Legs pale except at the joints, where they are dusky or black; tarsi black. Abdomen pale green, with a marginal row of black spots, and in the middle a large subquadrate patch of black, as wide as the distance between the honey-tubes; ventral uniformly greenish. Honey-tubes reaching to the tip of the style, narrow at base, then expanding, becoming widest a little above the middle, where they are at least twice as wide as at base, again contracting near the tip ending in a flat rim; color pale, dusky only at the tip. Style about half as long as the honey-tubes, cylindrical, point rounded, hairy and bent upwards, yellowish. Length of body .08; to tip of wings .16; honey-tubes .02.

Wingless form. General color pale-greenish. Antennæ as in winged form, but pale, or joints dusky only at tips. Legs pale, tarsi black. Honey-tubes the same but somewhat thicker, and not so distinctly clavate.

4. Rhopalosiphum nabali, n. sp.

Habit. Found on the flower-heads of *Nabalus albus*, Hook.

Winged form. Head broader than long and nearly straight in

front; color brownish-black. Antennæ on rather short frontal tubercles, about reaching to the honey-tubes; III longest, IV a little shorter, V a little shorter than IV, VI short, about one-fourth of V, VII seems usually to be short, not longer than VI, in only one specimen out of a dozen did I find one that had it as long as III, black in color, and III and IV rather strongly tubercular as in the foregoing species. Beak reaching second coxæ, or but slightly beyond it, pale except at tip. Prothorax with the pronotum narrowed in the middle; color shining brown or blackish, as are the lobes of the mesothorax. Eyes reddish-brown, with tubercle; ocelli present, bordered by black. Wings with the costal veins yellowish, rest brownish; stigma long and narrow; third discoidal obsolete at base. Legs blackish except basal half of femora. Abdomen greenish with a longitudinal middle and marginal band of blackish. Honey-tubes reaching beyond the tip of the style, strongly club-shaped, narrow near the base, then enlarging, becoming at least twice as wide as at base, again contracting more moderately near the tip, ending in a flat rim, brownish or black, base usually paler. Style rather long, about one-half the honey-tubes, slightly enlarged in the middle, bent upwards, hairy and yellowish in color. Length of body .10; to the tip of wings .20.

Wingless form. General color a dusky-green with head and thorax usually yellowish-green. Antennæ about two-thirds the length of the body. Honey-tubes and style as in winged form. Legs pale except at the joints, where they are slightly dusky. Wing-pads of the pupæ pale yellow.

This species comes nearer to *Siphonophora* than *Aphis* in size, color and general appearance, but the honey-tubes are distinctly club-shaped, and the frontal tubercles are but moderately large and hardly approximate.

VII.—SIPHOCORYNE, Pass.

Head transverse, rounded in front.
Eyes with a distinct tubercle; ocelli present.
Antennæ on no perceptible frontal tubercles; shorter than the body and usually strongly cicatrized and tuberculated.
Beak moderately long.
Wings and legs as in Aphis.
Honey-tubes distinctly clavate; moderately long.
Style short.
Typical American species: *Siphocoryne xanthii*.

1. Siphocoryne xanthii, n. sp.

Habit. Found on the leaves of *Xanthium canadense*, Mill. (X. *strumarium* of Gray's Manual).

Winged form. General color yellowish-green, some more decidedly green than others. Head transverse, rounded in front, more or less dusky above. Antennæ on no perceptable frontal tubercles, about one-half the length of the body, or a little longer, blackish except near the base; III longest and as long as IV and V together, IV and V subequal, VI about one-half of V, the setaceous VII about as long as III; III and IV strongly tubercular. Eyes reddish-brown, with tubercle; ocelli present, bordered by a ring of black. Beak short, not reaching second coxæ; last joint short and pointed, dusky. All the lobes of thorax blackish. Wings hyaline, and venation much as in *Siphonophora*. Legs pale, except at the tip of the joints blackish. Abdomen oblong, yellowish-green with transverse markings of darker green; ventral uniformly greenish. Honey-tubes reaching to the tip of the abdomen or slightly beyond, pale, basal half slender, then enlarging in the middle to nearly twice the diameter at the base, again contracting near the tip, ending in a flat rim. Style short, about as long as the tarsi, pointed, curved upwards, hairy. Length of body .08; to tip of wings .14.

Apterous form. Color pale greenish, with dorsal markings of darker green; ventral uniformly green. Body with short capitate hairs. Antennæ one-half as long as the body, pale. A red variety is also seen among very young specimens.

2. Siphocoryne archangelicæ, n. sp.

Habit. Found on the umbels of *Archangelica atropurpurea*, Hoffm. It is possible that this is *Aphis archangelicæ* of Linnæus, but I have no access to his description at present.

Winged form. Head transverse, pointed in front, brownish-black. Antennæ on no frontal tubercles, not more than one-half the length of the body, black or blackish; III longest and about as long as the three following joints taken together, IV, V and VI being subequal, VI being slightly the shortest, the setaceous VII also very short; III, IV and V are strongly tubercular, III especially so. Eyes dark reddish-brown, with

tubercle; ocelli present, but not very conspicuous. Beak moderately long and slender, reaching to the second coxæ. Pronotum of the prothorax narrowed in the middle, concolorous with the head; membrane greenish. Lobes of thorax shining black. Legs pale, dusky at joints. Abdomen rather long, sides straight, yellowish-green with a large subquadrate patch of black in the middle; ventral uniformly colored. Honey-tubes reaching to the tip of the style, enlarging in the middle to about twice the diameter at the base, again becoming narrow near the apex, where they are about as wide as at base, ending in a flat rim. Style rather short and acute, pale. Length of body .09; to tip of wings .17.

Apterous form. General color yellowish-green. Antennæ very short, not one-half the length of the body; joints proportional very much as in winged form. Honey-tubes reaching to tip of abdomen, dusky, in form as above. Style short and conical. Beak reaching second coxæ. Legs rather short and stout. Length of body .08 to .09.

VIII.—Genus APHIS, Linn.

Head transverse, rounded in front; seldom straight.
Eyes moderately large or large, with a more or less distinct tubercle; ocelli present, but usually not very distinct.
Antennæ remote at base, not on frontal tubercles, or on very inconspicuous ones; usually smooth, and generally shorter than the body.
Beak moderately long.
Pronotum of prothorax usually narrowed in the middle, and often with a lateral tubercle.
Wings deflexed, and of the usual form.
Legs generally short and stout.
Honey-tubes cylindric or sub-cylindric, moderately long, very rarely none.
Style usually short, very rarely none.
Usually found in large colonies on annual plants.
Typical American species: *Aphis mali*, Fab.

Although this genus has many times been restricted, it is still one of the most unwieldy in the family. A well defined subdivision would therefore be very desirable, but it will require a very careful and special study of the whole genus as found in America. At present I can offer no suggestions in this line, and will only attempt to define as fully as possible the apparently new species, without any satisfactory order of arrangement.

1. Aphis frondosæ, n. sp.

Habit. Found on *Bidens frondosa*, Linn. Usually in very great numbers.

Winged form. Head transverse, rounded in front, black. Antennæ about as long as the body, black, on no frontal tubercles, as seen from the side, but on the inner side with rather strongly projecting lobes, as seen from above; III longest, IV and V subequal, VI about two-thirds of V, setaceous VII about as long as III; smooth, but III, IV and V are cicatrized, having a row of regularly placed spots on the under side, V with but a few, and rather far apart. Eyes reddish-brown, with tubercle; ocelli present. Thorax of uniform black. Abdomen greenish and more or less mottled with black markings above, forming a subquadrate patch not well defined. Honey-tubes reaching tip of abdomen, cylindrical, black. Style greenish-yellow, cylindrical, slightly curved upwards, about one-half the length of the honey-tubes, or about as long as the tarsi. Legs black with the front femora pale, and the tibiæ more or less pale in the middle. Wings hyaline, with narrow blackish veins; origin of the second branch nearer to the tip of the wing than to the origin of the first branch. Length of body .07; to tip of wings .14 to .15.

Apterous form, The pupa has the antennæ about as long as the body, blackish. Thorax greenish, wing-pads blackish. Abdomen pale green, yellowish around the honey-tubes, with a large subquadrate patch of dull green in the middle blending with the pale green of the body. Honey-tubes black, thickened slightly at base. Style short, conical. Length of body .07.

2. Aphis ageratoidis, n. sp.

Habit. Found on the flower-heads of *Eupatorium ageratoides*, Linn.

Winged form. Head transverse, slightly pointed in front, black. Antennæ on very inconspicuous frontal tubercles seen as lobes on the inner side, about two-thirds the length of the body, black; III long, IV a little shorter, V a little shorter than IV, VI about two-thirds of V, VII the longest; III and IV are regularly cicatrized on the under side, but not as promi-

nently so as in the foregoing species. Eyes reddish-brown, with tubercle; ocelli present. Beak reaching second coxæ, pale. Prothorax with the pronotum much narrowed in the middle and with a distinct lateral tubercle, black; membrane greenish; rest of thorax of a rather dull black. Wings as usual. Legs black except at the joints. Abdomen pale yellow, or sometimes light brownish, with a patch of dark green in the middle which is much longer than broad; ventral pale yellow. Honey-tubes reaching the tip of the style, blackish. Style rather slender, cylindrical, hairy, pale yellow and about as long as the tarsi. Length of body .06; to tip of wings .12.

Apterous form. General color pale yellow. Antennæ pale at base, rest blackish. Eyes with ocular tubercle; the pupa with brown uniform spots as rudiment of the future ocelli. Beak black at tip. Wing-pads of the pupa black, except at base. Legs pale except the apex of the tibiæ. Abdomen with a patch of dark green in the middle, this patch much longer than broad. Honey-tubes black, slightly thickest at base. Length of body .06. This species is very close to *Aphis frondosæ*, but in size it is somewhat smaller, in color paler and the patch of the abdomen is always longer than broad, while that of *frondosæ* is subquadrate and not so well defined, but blending with the general color of the body.

3. **Aphis eupatorii**, n. sp.

Habit. On the flower-heads of *Eupatorium perfoliatum*, Linn.

Winged form. Head transverse, nearly straight in front or but a little rounded. Antennæ rather short, not more than two-thirds the length of the body, black except the base of the third joint; III longest, IV and V subequal, each considerable shorter than III, VI shortest about two-thirds of V, VII as long as V, III and IV cicatrized but not regular nor as well marked as in the two foregoing species. Eyes large, reddish-brown, with a very prominent ocular tubercle; ocelli present. Beak rather long and slender, reaching nearly to the abdomen. Prothorax with the pronotum narrowed in the middle; sides with a very distinct mammiform tubercle, black; membrane paler; rest of thorax black. Legs pale or of the same color with

the body, with the joints blackish. Abdomen yellowish or greenish-yellow, with a marginal row of black spots, and the last segments more or less blackish. Honey-tubes rather short, hardly reaching tip of the abdomen, and not much longer than the rather long tarsi, cylindrical, ending in flat rim, pale. Style conspicuous and nearly as long as the honey-tubes, cylindrical, curved upwards, hairy, yellowish in color. Length of body .07 to .08; to tip of wings .14.

No description was taken of the wingless forms at the time, so I can say nothing in regard to them, but the species can easily be recognized from the two foregoing from a somewhat larger and more robust form, the form of the antennæ, and the rather short honey-tubes but long style.

4. Aphis marutæ, n. sp.

Habit. Found on the flower-stalks of *Maruta cotula*, D. C.

Winged form. Head transverse, rounded in front. Antennæ on inconspicuous frontal tubercles, but these slightly prolonged on the inner margin, nearly as long as the body, all black except base of third joint; III long, IV but a little shorter, V a little shorter than IV, VI about one-half of V, VII as long as III; III and IV quite tubercular, especially on the under side, but very slightly and indistinctly cicatrized. Eyes dark reddish-brown, with tubercle; ocelli present. Beak reaching second coxæ, blackish. Thorax uniformly black; pronotum of prothorax narrowed in the middle with no lateral tubercle. Legs with the base of femora and tibiæ pale, rest black. Abdomen pale green, with more or less black markings above; ventral uniformly pale green. Honey-tubes rather short and stout, cylindrical or slightly enlarged in the middle, black. Style short, conical, concolorous with abdomen slightly dusky. Length of body .06; to tip of wings .12.

Abdomen greenish, with a marginal row of black spots above the honey-tubes, in the middle a large subquadrate patch of black.

Wingless form. General color greenish. Antennæ about one-half the length of the body, basal half pale, rest blackish. Pupa with the tips of wing-pads black. Honey-tubes short and usually a little thicker at the base, blackish.

This species is very similar to *Aphis eupatorii*, but is easily recognized by the large patch of black on the abdomen, and that the prothorax have not got the lateral tubercle found in the three foregoing species.

5. Aphis mali, Fab.

This species has been found very abundant throughout the season on the common apple, crab-apple, and also on the mountain ash. As far as I am aware it has not been noticed on the last named before. Wherever noticed the eggs were laid very numerous during October and November, on the trunks, twigs and annual shoots of the trees. It would be well to have the annual shoots and supernumerous twigs burnt in the fall or early spring before the eggs hatch, if they are found to be thickly stocked with eggs, as it would go so far towards diminishing their numbers. The eggs are pale green when first laid but soon become hard and black, very smooth, cylindrical, about as long again as broad.

6. Aphis pruni, Koch.

This species was noticed once on a young plum tree, but not very numerous.

7. Aphis maidis, Fitch.

This species, found on the Indian corn, is probably found now wherever corn is cultivated.

8. Aphis apocyni, Koch.

A species found on *Apocynum cinnabinum*, I take on Dr. Thomas' authority as identical with the European species as I neglected to take any notes or make comparison when found.

9. Aphis ripariæ, n. sp.

Habit. Found on the underside of the leaves of *Vitis riparia*, Michx.

Winged form. Head slightly pointed in front, of a dull black. Frontal tubercles very inconspicuous, only a slight projection on

the inner side. Antennæ about as long as the body, black except base of third joint; III longest, IV and V subequal, VI about two-thirds of V, VII nearly as long as III, setaceous; III and IV moderately pustulate on the under side not apparently cicatrized. Eyes reddish-brown, with ocular tubercle; ocelli present. Beak reaching second coxæ. Prothorax with the pronotum narrowed in the middle, black; membrane greenish; sides with a prominent tubercle. Thorax dull black. Second branch rather short, nearer to the tip than origin of the first. Legs pale except at the joints, black. Honey-tubes reaching tip of abdomen, about twice as long as the tarsi, cylindrical, or but slightly thickest at base, black. Style about as long as the tarsi, cylindrical, rounded at tip, hairy, pale in color. Length of body .08; to the tip of wings .15

Wingless form. General color pale yellowish-green. Antennæ about one-half the length of the body or a little longer, and usually quite pale. Legs pale except at the tips. Honey-tubes as in winged form, slightly dusky at tip. The joints of the antennæ are nearly equal in length, except the last usually being the longest; the division of joint III and IV is very indistinct. General form of the body rather long and narrow, in this respect, showing same relation to Siphonophora.

10. Aphis polanisiæ, n. sp.

Habit. Found on the seed-pods and occasionally also on other parts of the plant of *Polanisia graveolens*, Raf. The first species found on a plant of this order I believe.

Winged form. Head strongly transverse, rounded in front, black. Antennæ one-half or not more than two-thirds the length of the body, black, on very inconspicuous frontal tubercles; III longest, IV about two-thirds of III, V a little shorter than IV, VI one-half of V, VII about as long as III; III and IV strongly tubercular and cicatrized. Eyes blackish with a large ocular tubercle; ocelli present. Prothorax with a moderately distinct lateral tubercle; thorax as a whole black. Wings as usual in the genus, but coming near to the type of *Siphonophora;* stigmal vein but slightly curved. Legs rather long and slender; femora pale at base; tibiæ rather pale except at apex together

with the tarsi which are all black. Abdomen greenish-black. Honey-tubes rather short and thick, not reaching tip of abdomen, and hardly twice the length of the tarsi. Style about as long as the tarsi, and as usual. Length of body .06; to tip of wings .12 to .14.

This species, like the one found on the common tomato, have often got their feet clogged with the viscous substance of the plant, so as to appear club-footed.

Wingless form. These are usually found on the pods, congregating in small colonies, and rather uniformly of the same green color as the pods.

11. **Aphis annuæ,** n. sp.

Habit. On the leaves and flowering-stem of *Poa annua*, L., found together with *Siphonophora granaria*, but this species generaly was found only on the leaves and lower part of the plant, while the aphis on the upper.

Winged form. Head and thorax of a shining black; abdomen of a dull green. Head transverse as usual, and rather strongly pointed in front. Antennæ a little shorter than the body, on no frontal tubercles but only a small projection on the inner side taking the place of it, all black; III long, IV a little shorter, V shorter than IV, VI about one-half of V, VII as long as III or sometimes longer, setaceous; the middle joint but moderately tubercular and indistinctly cicatrized. Beak as usual, black at tip. Eyes with ocular tubercle; ocelli present. Prothorax with no lateral tubercle, and as well as the rest of thorax shining black. Wings rather long and narrow; stigmal vein but moderately curved; second branch of the discoidal very short and near to the tip. [One specimen examined had the second branch missing on one of the wings, the other being normal.] Legs more or less pale. Abdomen of a dull green, sometimes with a marginal row of black spots, but usually quite uniformly colored throughout. Honey-tubes short, hardly twice the tarsi and not reaching tip of abdomen, cylindrical or slightly narrower on the basal half and near the tip, tip ending in a flat rim, color black. Style short, cylindrical, about as long as the tarsi, black. Length of body .07; to tip of wings .14.

Wingless form. The larvæ are rather short with the abdomen wide and strongly rounded behind, of a dark dusky green. Antennæ reaching base of honey-tubes, dusky.. Honey-tubes as in winged form but usually pale at base. Style very short, conical. Length of body .06 to .07.

This species is readily recognized from the closely related species by the very short second branch of the wings.

12. Aphis asclepiadis, Fitch.

Found in colonies on the upper leaves of *Asclepias cornuti*, Linn. Apparently Aphis and not Siphonophora as Doctor Thomas considers it. This I found to be very common in this part of the state.

13. Aphis brassicæ, Linn.

It can usually be found on the cabbage wherever it is cultivated. They occur in small colonies distributed over the outer leaves, and for the last season have been found very numerous in certain localities of this state.

14. Aphis ceracifoliæ, Fitch.

Found on the upper leaves of *Prunus virginiana*, Linn., causing them to twist and curl.

15. Aphis loniceræ, Monell.

This very peculiar species was once taken on *Lonicera glauca*, Hill.

16. Aphis phragmitidicola, n. sp.

Found on the leaves of *Phragmitis communis*, Linn., in small colonies along the midrib. It is possible that this may be the Linnean species *arundinis*, but at present I have no means to ascertain this and will therefore describe the species as found here.

Winged form. Rather long and narrow, somewhat flattened. Head and thorax black and with a slight pulverulent. Antennæ about as long as the body, dusky except at base, on no frontal

tubercles or only a very slight lobe seen on the inner side; I sometimes slightly gibbous, III longest, IV a little shorter, V a little shorter than IV, VI about one-half of V, VII usually as long as III; smooth and apparently not cicatrized. Eyes reddish-brown, with ocular tubercle; ocelli present. Beak rather short and blunt, not reaching second coxæ, pale except at tip. Thorax with the lobes black; prothorax rather large, green in color, with a very small and inconspicuous lateral tubercle. Wings with the stigma long and narrow; stigmal vein but moderately curved; third discoidal obsolete at base. Legs moderately long and slender, pale except at joints, where they are slightly dusky. Abdomen long and narrow, sides straight, tapering behind, flat; color uniformly pale green. Honey-tubes short, hardly as long as the tarsi, and but a little longer than broad, cylindrical, rounded at tip, slightly dusky. Style larger and more conspicuous than the honey-tubes, about as long as the tarsi, cylindrical, sometimes slightly curved upwards, hairy. Length of body, .06; to tip of wings .12.

Wingless form. Long and narrow, flattened. Color pale green, with marginal and a middle band of dark-green; more or less covered with a white powder. Beak short and thick, not reaching second coxæ. Legs pale except the tips of the tibiæ and the tarsi. Honey-tubes and style as in the winged form. Antennæ a little shorter than the body or else as in the foregoing form. This species has the honey-tubes situated rather far up on the abdomen.

17. **Aphis middletonii,** Thomas.

This interesting species was taken abundantly during the summer on the roots of *Erigeron canadensis*. This species is usually protected by some colony of ants, who will take them up and carry them off to some safe place as soon as disturbed. If this is but a dimorphic form, as Doctor Thomas suggests, it will probably develop another interesting page in the life history of this family. But as far as my own observations go I can add nothing to it. The winged form so far has never been found. This species, although living under ground, is not exempt from parasites, as some species of Aphidius penetrate even to their deep abode and

sow destruction among the colony. A plant pulled up, containing a colony of this species, had almost every one affected, more than half of the colony still clinging to the roots with a wide hole on the abdomen from which the imago had made his escape. One imago was taken apparently busy in laying its eggs in the few still remaining. They were first seen in early part of September, when they were found under almost every plant in the sandy soil along the river, but later on in the fall when the plants had died, I could not find any trace of them, even where they had been very plentiful a short time before.

18. Aphis frigidæ, n. sp.

Habit. Found together with *Siphonophora frigidæ* on *Artemisia frigida*, a very characteristic species in some respects, but undoubtedly a true Aphis. So far only the wingless form has been observed.

Wingless form. General color varying from a pale to a rather dark reddish-brown; the whole body being covered by a white pulverulent. The body is also covered by a rather thick pubescence of fine and short white hairs, not seen without the aid of a glass. Head transverse, straight in front; a medio-longitudinal suture is seen from the front of the head running down some distance of the body. Antennæ shorter than the body, sometimes reaching the base of the honey-tubes, on no perceptible frontal tubercles, pale at base, apical half more or less blackish, smooth; I and II subequal and as usual; III, IV and V subequal, or III slightly the longest; VI two-thirds of V; VII the longest, longer than III. Beak rather long and sharply pointed, reaching the third pair of coxæ; first joint pale, second and third black, third very narrow and sharply pointed. Abdomen oval, convex, or in oviparous females the tip is usually much drawn out. Legs rather short, pale except the tips of tibiæ and the tarsi, black; coxæ often also black. Honey-tubes long, reaching tip of the abdomen, longer than the femora, and about three times the tarsi, cylindrical, ending in a very conspicuous round knob, which is as wide again as the width of the honey-tubes. Of a great many specimens examined all presented this character, which as far as I know is peculiar to this species. Color pale and

transparent, or but slightly dusky. Style about as long as the tarsi, cylindrical, rounded at end. Anal plate of oviparous females black and hairy. Length of body .05 to .06.

The habit of this species is more active than any Aphis with which I am acquainted, in this respect coming nearer to Siphonophora.

19. Aphis rumicis, Linn.

Found occasionally on the common dock (*Rumex*).

20. Aphis atriplicis, Linn.

Found on *Chenopodium album*, Linn.

21. Aphis cornifoliæ, Fitch.

This species is rather common on the dog-wood.

22. Aphis setariæ, Thomas.

Found very common on the heads of *Panicum crus-galli*, Linn., and *Setaria glauca*, Beauv. What is apparently the same species was also taken on *Ampelopsis quinquefolia*, Michx.

23. Aphis carduella, Walsh.

Found on *Cirsium lanceolatum*, L.

24. Aphis aparines, Fab.

Found on *Galeum aparine*, Linn., and probably identical with the European species, the plant it inhabits being common to the two continents. But as I have no description of this species as found in Europe, I give one as found here.

Winged form. General color shining black. Head slightly pointed in front. Eyes dark-brown, with a well developed tubercle; ocelli present. Antennæ about as long as the body, black, on moderately developed frontal tubercle, especially as seen from the inner side, where they are slightly gibbous; III long and slightly pale at base, IV and V subequal, VI about one-half of V, VII as long as III or sometimes slightly longer, setaceous; III—V slightly tubercular, cicatrized with small and

irregularly placed spots. Beak moderately long reaching second coxæ. Prothorax with no lateral tubercle, shining black but transversely ridged, with membrane slightly pale; rest of thorax all black. Wings with stigmal vein strongly curved on its basal half; third discoidal obsolete at base; stigma slightly dusky, long and narrow. Legs with the femora pale at base, tibiæ pale except at tip, tarsi all black. Abdomen black. Honey-tubes reaching tip of abdomen, about twice the length of the tarsi, cylindrical, black, ending in a flat rim. Style short. Length of body .06; to tip of wings .12.

Wingless form. General color a dull dark brown or black. Pupæ with the thorax and wing-pads slightly paler, the tip of wing-pads black. From the front of the head there is seen a medio-longitudinal line extending down nearly the whole length of the body. Antennæ reaching the base of the honey-tubes; relative length of the joints as above, but they are smooth and slightly paler; frontal tubercles rather more gibbous. Eyes dark reddish-brown, with a prominent tubercle. Legs and honey-tubes of the same color with the body, or somewhat darker.

This species shows some characters of Siphonophora, but in habit and general appearance is undoubtedly a true Aphis.

IX.—Genus CHAITOPHORUS, Koch.

Head rather broad and straight in front.
Eyes with ocular tubercle; ocelli present.
Antennæ not on frontal tubercles, usually shorter than the body, distinctly pilose or hairy.
Beak moderately long.
Wings as in *Aphis*, but the veins sometimes bordered by black.
Style tubercle-like.
Honey-tubes reduced to mere tubercles, hardly longer than thick, or rarely obsolete.
Body of the apterous form usually tuberculated, and with long slender hairs.
Usually found on the leaves of trees.
Typical American species, *Chaitophorus populicola*, Thomas.

1. Chaitophorus populicola, Thomas.

Found on the under side of the leaves of *Populus monilifera*, Ait.

2. Chaitophorus negundinis, Thomas.

This species is probably one of the most injurious in this locality, the apple plant-lice probably excepted. It is found very common on the box-elder (*Negundo aceroides*, Moench.), caus-

ing the leaves to turn black and become unsightly by puncturing them. During October, when the leaves are falling, the apterous oviparous females can usually be seen in very great numbers around the limbs and twigs busy depositing their eggs around the winter buds and in every crevice, especially on the under side of the limbs, where they can find a safe place to deposit.

3. Chaitophorus nigræ, n. sp.

Habit. Found on the leaves of *Salix nigra* as late as October 26th.

Winged form. Similar to Aphis in general appearance. Entire insect with long white hairs. Head black, rather straight in front. Antennæ about as long as the body, black except base of III; I and II as usual and subequal, III longest, IV a little shorter, V a little shorter than IV, VI about one-half of V, VII as long as IV, setaceous; III—V moderately cicatrized. Eyes dark reddish-brown, with a prominent tubercle. Beak rather short, hardly reaching second coxæ, pointed. Thorax all black, prothorax well developed, pronotum not narrowed in the middle. Wings as usual. Legs with the femora more or less blackish, and the tibiæ pale. Abdomen wholly black or slightly pale, brown along the sides. Honey-tubes tuberculiform, not longer than broad, thickest at base, usually paler than the body. Style tubercle-like, or even knobbed as in Callipterus. Length of body .06; to tip of wings .10.

Wingless form. General color a dull blackish-brown. Body flat, obovate or oblong, quite hairy and tubercular in young specimens, becoming smooth in full grown. Antennæ about one-half the body or a little longer, pale at base, dusky towards the apex; relative length of the joints as in winged form; joints with long white hairs, not very numerous. Abdomen usually with the middle and the margins slightly paler. Honey-tubes as in the above form. Length of body .06.

5. Chaitophorus spinosus, n. sp.

Habit. Found on the under side of the leaves of the oak. A very characteristic and well marked species. The species seems to confine itself to the higher parts of the tree, as I never found

it on the lower limbs that I observed during the summer, where *Callipterus discolor*, Monell, was always found; and it was not until the 17th of October, when several oaks were cut on the campus that I found this species. Only the wingless form has so far been observed.

Wingless oviparous females. Head subquadrate in outline, straight in front, pale red or orange colored, with blackish spines in front and above like those on the abdomen. Antennæ very remote at base, about one-half the length of the body; I and II as usual, III longest, IV a little shorter, V a little shorter than IV, VI hardly one-half of V, VII not longer than VI or shorter; basal joints pale, apical black, with long white hairs as usual in this genus. Eyes large and round, with a distinct tubercle; the facets are reddish-brown, the space between them whitish, giving the eye the appearance of a ripe raspberry just picked with the bloom still on; no ocelli in this form. Beak not more than reaching second coxæ, stout and hairy, pale except at tip; second joint widest. Abdomen widest in the middle, tapering into a very long ovipositor behind, strongly convex above. Color pale yellow, uniformly so on the ventral; last segments sometimes reddish as the head; above with grass-green markings, generally in the shape of a ring, leaving a large patch in the middle of the same color as the abdomen, with projections as follows: one in front, one behind, and two on either side, the one behind reaching down between the honey-tubes. These green markings give an outline somewhat similar to that of a turtle with its head, tail and feet all spread out, but they are sometimes more or less obscure. Above the abdomen has transverse rows of spine-like hairs, black in color and very rigid, usually disposed in groups of one to four, but the spines of each group are rather far apart. The abdomen as well as the entire body has the usual long white hairs of this genus disposed between the spines Honey-tubes short and thick, about as long as thick, and not quite as long as the tarsi, of the same color with the body. Style short and thick, tuberculiform, hairy. Legs are pale except the tips of the tibiæ and the tarsi, which are black. Length of body .10—.12. As stated above, this form has the abdomen very much drawn out so that the average length of the apterous form probably will not exceed .10.

X.—Genus CALLIPTERUS, Koch.

Head broad and straight in front.
Antennæ not on frontal tubercles, or else on very short ones, seven-jointed; transition from the sixth to the seventh very gradual.
Eyes large and round, with a distinct tubercle, usually of a bright red color; ocelli present.
Beak short.
Wings deflexed; front wings with the stigmal vein much curved, not robust, usually more or less hyaline; cubital vein springing from near the base of the stigma; second discoidal sinuous. Hind wings with two discoidals.
Honey-tubes short, often hardly perceptible.
Style short, enlarged at apex
Body elongate, slender, of very pale colors.
Habit sporadic.
Typical American species, *Callipterus discolor*, Monell.

1. Callipterus ulmifolii, Monell.

Found on the underside of the leaves of *Ulmus americana*, L.

2. Callipterus asclepiadis, Monell.

Very common on *Asclepias cornuti*, L.

3. Callipterus discolor, Monell.

This species together with *Chaitophorus spinosus* are the most common and abundant on the oaks around Minneapolis.

4. Callipterus betulæcolens, Fitch.

Found on *Betula papyracea*, Ait. Dr. Fitch is apparently entitled to this species.

5. Callipterus caryæ, Monell.

On *Carya amara*, Nutt. Very rare as far as observed in this locality.

XI.—Genus LACHNUS, Illiger.

Head small and narrow.
Antennæ not on frontal tubercles, usually quite short, seventh joint not longer than the sixth, and often reduced to a minute spur at the tip.
Eyes large and round, with tubercle; ocelli present.
Beak long and rather slender, extending to and even beyond the posterior coxæ.
Wings with third discoidal twice forked; stigma long and narrow, more of a linear shape; stigmal vein nearly straight or but slightly curved. Posterior wings with two branch veins.
Honey-tubes usually very short, sometimes almost obsolete.
Style obsolete, or very short.
Usually found on branches of trees.
Typical American species, *Lachnus salicicola*, Uhler.

1. **Lachnus salicicola,** Uhler.

This is the only species so far observed in this state, yet I do not doubt that most of those found in America will eventually also be found here, as they usually inhabit trees that are common over the greater part of the state. The species has been found very common and abundant on several varieties of willow from early May to late in November. Once also taken on the young twigs of a poplar (*Populus*). In early spring especially they exude very abundantly a clear watery fluid, but it seems not to have that sweet quality usually found in the family of plant-lice, as no ants were ever observed to feed on it. On being crushed they stain the hand a deep red.

The eggs are laid in October and November on the limbs, and especially around the winter buds.

XII.—Genus MASTOPODA, g. nov.

Head transverse, rounded in front.

Antennæ on no frontal tubercles, remote at base; about as long as the body; six-jointed (very probably by the union of the third and the fourth); the third and setaceous seventh longest.

Eyes with inconspicuous tubercle; ocelli present.

Beak long, reaching third coxæ.

Wings as in Aphis, but the venation quite variable.

Legs moderately long; tibiæ all truncated at the tip, and with rudimentary tarsi, only a short mammiform tubercle with no claws, takes the place.

Honey-tubes moderately long, cylindrical.

Style short and tubercle-like.

Found in large colonies as Aphis

Typical species, *Mastopoda pteridis*.

The anomalous species for which this genus has been erected will not fall into any of the genera so far as known to me. In size, form and habit, it comes nearest to *Aphis*, and as to the six-jointed antennæ it could be put in *Sipha* together with *Sipha rubifolii* of Doctor Thomas. But the peculiar form of the tibiæ and the rudimentary tarsi will exclude it from either. I confess that I am unable to account for this peculiar structure, or what importance should be assigned to it. There seems to be nothing analogous to it either in this family or order of insects under consideration.

Although the form of the antennæ will put it in the section *Lachnini* I think it could be put in *Aphidini* with as much pro-

priety, especially if we take into consideration the setaceous and long character of the last joint, and the probable union of the third and fourth joint forming the third in this species.

1. **Mastopoda pteridis,** n. sp.

Habit. Found in large colonies on the underside of the fronds of *Pteris aquilina*, L., or common brake.

Winged form. Head transverse, rounded or slightly pointed in front as in Aphis, flat above with a slight impression in the middle, black or blackish. Eyes dark-brown; the ocular tubercle hardly perceptible; ocelli present and conspicuous, bordered by a ring of deeper black. Antennæ not on frontal tubercles, remote at base, about as long as the body; 6-jointed, black; I and II subequal and slightly narrower at base; III very long and thick, narrow at the insertion with II, longer than IV and V together; IV about one-half of III, similar to it; V short about one half of IV, narrower and smooth; VI long and setaceous, usually as long as III. Beak long, reaching third coxæ, pale except at tip. Pronotum of the prothorax narrowed in the middle, with no lateral tubercle, black or blackish with the membrane greenish. Thorax all black, slightly shining. Wings as in Aphis, but the venation varies a great deal; third discoidal obsolete at base; second branch about as far from the margin as from the origin of the first; second pair of wings with two discoidals, but the second sometimes obsolete, and with two rather long and slender hooklets. Legs pale brownish or more or less dusky with only the tips of tibiæ quite black; tibiæ are rather long and somewhat enlarged at the tip, which is truncated and apparently hollow and with no tarsi proper; a short mammiform tubercle, rounded at end, with no claws, from the inner side of the hollowed tibiæ is all that can be found as a rudimentary tarsus. I have examined a great many specimens in all stages and at different times, but have not found the slightest variation in this respect. Apparently they walk on the perpendicular surface of glass with more ease than any other species in this family. Abdomen pale green or yellowish-green, more or less dusky in the middle, sometimes forming a well defined subquadrate patch; ventral uniformly pale. Honey-tubes compara-

tively long, about as long as the distance between them, cylindrical, dusky or black. Style very short and tuberculiform, hairy, concolorous with body. Anal plates hairy; the upper transverse and usually pale, the lower concave on the inner side and usually dusky. Length of body (males) .05 to .06; to tip of wings .10 to 11.

Apterous forms. The pupa-form is very conspicuous by its reddish-yellow head and thorax, the abdomen being pale yellow; tip of wing-pads pale. Antennæ as in foregoing form, reaching honey-tubes. Eyes large, but the tubercle is not very conspicuous; ocelli rudimentary as brown spots. Honey-tubes reaching tip of abdomen, usually pale, sometimes dusky. Legs pale; tarsi rudimentary as above. Larvæ are slightly smaller, pale yellow, with tortoise-shell markings on the abdomen. Legs and honey-tubes pale. Length of pupa .07. Length of larvæ .05.

The venation of this species probably varies more than in any other so far as known. I give the result of 14 specimens taken at chance and examined in reference to this.

Six had both wings normal.
Three had one wing normal and the other with the third discoidal but once branched.
One with the stigmal vein nearly straight in both, and with one-half of the second forkal obsolete in one of the wings.
One specimen with the second branch obsolete in one of the wings, and the same rudimentary in the second.
One specimen with one wing normal; the second with the forkal of the first branch rudimentary.
One specimen with the stigmal vein in one of the wings once-branched.
One specimen with the third discoidal three times branched in one of the wings, and the stigmal vein once.

XIII.—Genus SCHIZONEURA, Hartig.

1. Schizoneura americana, Riley.

Found on the white elm (*Ulmus americana*, L.,) causing the leaves to curl and become disfigured. Very common especially on young trees.

2. Schizoneura panicola, Thomas.

This very peculiar species, from its inhabiting the roots of grasses, is found rather common in this locality on *Panicum glabrum*, L., *Setaria glauca*, Beauv., and *Eragrostis pectinacea*,

var., *spectabilis*, Gray. The winged form was observed plentiful September 20th. Ants were generally found to herd this species.

3. **Schizoneura querci,** Fitch.

What was taken to be this species was taken on oak, but only apterous form so far seen.

XIV.—Genus COLOPHA, Monell.

1. **Colopha compressa,** Koch.

The cock's-comb gall of the white elm. (*Ulmus americana,* L.) So far I have not found it very common in this locality.

XV.—Genus PEMPHIGUS, Hartig.

1. **Pemphigus populicaulis,** Fitch.

Found rather common on *Populus monilifera*, Ait. I have also this species from Nicollet county.

2. **Pemphigus populi-transversus,** Riley.

Like the last found on *Populus monilifera,* Ait. along the river-bank. Sometimes the two were taken together on the same tree.

3. **Pemphigus vagabundus,** Walsh.

The unsightly black galls of this species too often disfigure the poplars in and about Minneapolis as they remain over winter. Young trees seem especially to be effected, and often almost every twig ends with one of these galls.

4. **Pemphigus rhois,** Fitch.

Found rather sparingly on *Rhus glabra*, L.

XVI. –Genus TYCHEA, Koch.

1. Tychea radicola, n. sp.

A few very peculiar specimens were found on the roots of *Ambrosia trifida*, L., September the 14th, but as I did not succeed to find it again, I am not quite satisfied as to its generic position. I will give my notes as taken at the time.

Apterous form. Head nearly as broad as long, rounded in front; two small spots of black, these probably are rudiments of eyes. Antennæ 5-jointed (or 6-jointed counting the spur on the last as one), pale or only slighty dusky towards the tip; I and II short and subequal, III longest and about as long as the two first, IV but a little shorter, V as long as III counting the spur, or else about as long as IV; smooth, or with a few short and slender hairs near the apex of each joint. Beak very long reaching to the middle of the abdomen; first joint longest reaching slightly beyond the third coxæ, second short, last but a little longer than second, gradually narrowed to a point but not sharply so; two last joints slightly dusky. Abdomen suborbicular, very convex above, color whitish (as is the whole insect), the margin with a row of small tufts of white flocculant matter. No honey-tubes apparent. Style short, globular, with some rather long and curved hairs. Length of body .06.

The University of Minnesota, Dec. 1, 1885.

III.

REPORT ON THE LOWER SILURIAN BRYOZOA WITH PRELIMINARY DESCRIPTIONS OF SOME OF THE NEW SPECIES.

By E. O. ULRICH.

The bryozoa are unusually abundant in the Lower Silurian strata of Minnesota. This is especially true of the Trenton shales, in which they constitute about two-thirds of the entire fauna. Many of the species are extremely abundant, and the thin slabs of limestone are largely composed of their fragments. The shales immediately succeed the "Buff limestone," in which but few remains of this class of fossils occur. Those observed, moreover, are so badly preserved that it was found impossible to determine the species. Just below this limestone and resting on the St. Peter sandstone, is found the building stone commonly used at Minneapolis. This limestone does not appear to belong to the Trenton group, and, judging from the fossils, seems rather to indicate an equivalence with the Chazy, or, perhaps, Black River. These strata are not present in the sections studied in Wisconsin and Illinois, where the "Buff limestone" rests on the St. Peter sandstone, but at High Bridge, Ky., they are represented by a mass of rock several hundred feet in thickness. The beds in the neighborhood of Lebanon, Tenn., seem to belong to the same age. The shales which are here called Trenton, are assigned in some preceding reports to the "Hudson River" group, but the fossils contained in them, notably the bryozoa, show conclusively that that is not their true position. Of the eighty-three species of bryozoa obtained from them, no less than twenty-five are identical

with species occurring in the Trenton of New York, Canada, and Tennessee. That they really belong to the Trenton is further shown by the fact that they are superseded by the Galena.

In the following list are noted all the species so far studied. More extended investigations will, I do not doubt, swell the number some twenty or thirty more. Because of other engagements I did not have the time required to write out descriptions of all the new species, but this is scarcely a cause for serious regret, since the survey proposes to publish, at an early date, full descriptions and illustrations of all the species found in the state.

BERENICEA MINNESOTENSIS, n. sp.

Zoarium attached to foreign bodies, consisting of extremely thin patches, irregular in outline. Zooecia partially immersed, the exposed portion appearing as broadly-elliptical convex spaces, about 1-95th of an inch in their longest diameter. Apertures somewhat oblique, contracted, circular, 1-200 of an inch in diameter, and surrounded by a barely perceptible rim or peristome. The arrangement of the cells is usually more or less regular in curved diagonal lines; not infrequently, however, the specimens show considerable variation in the number occupying a given space, while here and there, a small non-celluliferous spot may be detected. From six to nine may be counted in the length of .1 inch, but the average number is about seven.

The relations of this species appear to be almost exactly intermediate between the two Cincinnati group species *B. primitiva* and *B. vesiculosa*. From the former it differs in having its cells less immersed, and the apertures less prominent but more distinctly contracted. In distinguishing *B. minnesotensis* from *B. vesiculosa*, the same differences become apparent, but reversed in their application.

Formation and locality: Not uncommon in the shales of the Trenton group, at Minneapolis, Minn.

Register No. 5925.

ROPALONARIA PERTENUIS, n. sp

Zoarium adnate; cells uniserial, very elongate-elliptical, about four in the length of .1 inch; from the proximal end, which is very slender and always more so than the anterior, the cell gradually increases in size until at the center or some point nearer the anterior end, it has assumed a diameter of about 1-130th of an inch. This point is marked by the presence of the subcircular aperture, which is surrounded by a very faint peristome, and has a diameter of less than 1-200th of an inch. At every fourth or fifth cell the series bifurcates; this cell is more abruptly swollen and larger than those intervening, while it differs still further in having its aperture situated quite near the anterior end.

This species is closely allied to the *Stomatopora* (*Ropalonaria*) *elongata*, Vine, from the English Wenlock deposits. Its relation to the type of the genus, *R. venosa*, Ulrich, from the Cincinnati group of Ohio, is however, still more intimate. The former it resembles in its growth, and the latter in the shape of its cells.

Formation and locality: Rare in the Trenton shales, at Minneapolis, Minn.

Register No. 5926.

HELOPORA DIVARICATA, n. sp

Zoarium segmented; segments cylindrical, poriferous on all sides, obtusely pointed at each end, and varying in length from two to four-tenths of an inch; their diameter varies between .02 and .03 inch. Zooecial apertures oblique, ovate, spreading anteriorly, and arranged in troughs between strong longitudinal ridges, six in the length of .1 inch. Passing around and forming the posterior border of the aperture is a faint ridge that on each side is obliquely directed across the longitudinal keels, where it meets a similar line proceeding from one of the cells in the adjoining series. These divaricating lines give to the strong vertical ridges the appearance of being marked by a succession of Λ-shaped furrows and elevated lines. Eight or nine rows of cells suffice to pass around a segment.

Beyond the fact that the zooecia are tubular and radiate in all directions from a central axis, the internal structure is unknown.

This species is clearly congeneric with *Helopora fragilis*, Hall, and *H. spiniformis*, Ulrich. The last species was originally placed by me in the genus *Arthroclema* of Billings.* At that time I had not yet succeeded in obtaining satisfactory sections of the type species of *Helopora*. Through the kindness of Mr. Arthur H. Foord, who sent me better material of the species than I had yet seen, I have since been enabled to work out its structure. In nearly all respects it is identical with that of *H. spiniformis*. This being the case, the question whether *Arthroclema* could be distinguished from *Helopora* by characters of more than specific importance at once presented itself. While I am not yet prepared to assert that the differential characters observed are really of generic value, still I believe that, provisionally, the best plan is to keep them separate. One of the most striking external features of the three species of *Helopora* now described, and two other species known to me, is found in the arrangement of the zooecial apertures between vertical ridges. These ridges are not obvious in the Canadian specimens of *Arthroclema pulchellum*, nor in the Minnesota examples at present doubtfully identified with that species. Instead, we find two or three more or less flexuous lines and grooves marking the inter-zooecial spaces. A more important difference is found in the reproduction of the segments. In the species of *Helopora* this is only terminal; while in *Arthroclema pulchellum* it is both terminal and lateral, there being two "sockets" situated just opposite each other on the opposite sides of each of the main segments for the articulation of the smaller lateral branches. The form of zöarium resulting from this mode of growth resembles that of a feather in having a strong central rib and more slender lateral branches. On the other hand. the mode of growth of *Helopora* seems to be precisely like that of *Arthronema*, Ulrich, in which each segment gives off from its upper termination one or two similar joints, Whatever course may be finally adopted in the disposition of *Helopora* and *Arth-*

*Amer. pal. bry., Jour. Cin. Soc. Nat. Hist., vol. v, p. 161, pl. 6, fig 10, 1 ¹a, 10b.

roclema, enough of their structure is known to make their reference to the fam. *Arthronemidæ* almost unquestionable.

Specifically, *H. divaricata* is distinguished from *H. spiniformis* by its slightly larger cells, more distinct longitudinal ridges, and their peculiar ornamentation.

Formation and locality: Rather rare at the base of the Trenton shales, at Minneapolis, Minn.

Register No. 5928.

PHYLLOPORA? CORTICOSA, n. sp.

Zoarium flabellate to funnel-shaped, undulating and irregular in growth, composed of anastomosing branches having a width varying from 0.015 to 0.035 inch. Poriferous side presenting the appearance of a *Fenestella* with carinate and more or less rigid branches, and much depressed dissepiments. On each side of the sharp and usually spiniferous median ridge, there are two rows of rather irregularly alternating circular cell-apertures, thirteen or fourteen of which occur in the length of 0.1 inch. The depressed dissepiments are short and carry two or three rows of cells. In rare instances this division of the frond into rigid branches and dissepiments is not recognizable. In such fragments, or portions of elsewhere normally constructed specimens, the branches anastomose rather irregularly and are simply convex, not carinate, the median ridge being apparently absent. Branches on the non-celluliferous side of frond faintly striated, and tending, though not so obviously as on the poriferous face, to form longitudinal ridges. Fenestrules varying in outline from elongate-elliptical to subcircular, with a width rarely more, usually a little less than that of the branches, and a length from one to three times the width. Measuring transversely, from six to eight occupy 0.2 inch; longitudinally, from two and a half to four occur in the same distance.

Tangential sections, cutting the frond through the plane of its expansion and near the middle of its thickness, show that the branches are divided into approximate halves by an obscurely double wall, thicker than those of the tubes, diverging from it toward each side. The tubes have thin walls, are long,

and divided by distinct straight diaphragms in their outer portion. Where the section divided the tubes just below their apertures they are seen to be subcircular, with slightly thickened walls, and partially separated from each other by angular interstitial or abortive cells, that may be considerably smaller or even a little larger than the true zooecia. Here and there, along the middle of the branch, one of the spiniform tubuli may be detected.

Vertical sections show that the zooecial tubes also arise from a thick basal membrane, from which they diverge in an upward and outward direction, that their approach to the celluliferous surface is very gradual in the lower half of the branch, and somewhat less so in the upper half. Here they are crossed by two or three unmistakable diaphragms, and their number increased by gemmation. These shorter tubes I am inclined to regard as representing the angular interstitial (abortive?) cells noticed in describing the tangential section.

In transverse sections the branches are sub-rhomboidal, the lateral diameter being the shortest. The median ridge is represented by an obscurely double vertical wall, dividing the branch into two nearly equal portions. Between the two laminæ forming this wall I can detect a series of very minute tubuli, such as are found between the median laminæ of many of the *Stictoporidæ*. The lateral portion of the circumference of the cells, (*i. e.* the half directed toward the sides of the branches,) is rounded or semi-circular, while the opposite half is wedge-shaped.

This species, though in many respects very peculiar, is unquestionably allied to such bryozoa as *Intricaria reticulata*, Hall, *I. clathrata*, S. A. Miller, *Retepora trentonensis*, Nicholson, *R. angulata*, Hall, *R. asperatostriata*, Hall, and *Phyllopora variolata*, Ulrich. These species are all congeneric, but there is no established genus to which they can be referred with certainty. In an earlier writing* I placed two of the species in King's genus *Phyllopora*, but, at present, I am inclined to believe that the type of that genus will prove to be quite a distinct form. Judging solely from Prof. King's figures and description the affinities of *P. ehrenbergi* seem to be not far

*"Amer. pal. bry." Jour. Cin. Soc. Nat. Hist. vol. v, p. 160.

removed from *Polypora*, McCoy, and *Lyropora*, Hall. Should this be the case, then it would be necessary to establish a new genus for the reception of the species above cited, as their relation to those genera is only very slight. In fact, I doubt that their peculiarities of structure will admit of their being arranged in the same family. Still until something further is learned of the structure of *P. ehrenbergi*, I have concluded to defer the erection of a new genus, and will, provisionally classify them with *Phyllopora*, adding the usual question mark.

Specifically, *P.? corticosa* is readily distinguished from other species of the genus, by the carinated character of the branches. A species, at present doubtfully identified with *P.? trentonensis*, Nicholson, occurs in what is called the building rock. These beds are the same as those occurring in the gorge of the Kentucky river at High Bridge, Ky., and at Lebanon, Tenn., and most probably represent the Chazy. The *P.? reticulata*, Hall, is quite common in the Trenton shales at Minneapolis.

Formation and locality: Trenton, at Oxford mills, Cannon Falls, Goodhue Co., Minn., where it is associated with *Streptelasma corniculum*, Hall, *Prasopora conoidea*, n. sp., and other fossils characteristic of the Trenton shales about Minneapolis.

Register No. 3495.

PTILODICTYA SUBRECTA, n. sp.

Zoarium consisting of an unbranched, flattened, two-edged, straight or slightly curved frond, that gradually expands from the acutely-pointed articulating "head" upward from 0.2 to 0.5 of an inch, the edges of the rest of the frond being parallel, or nearly so. The greatest width varies in different examples from 0.05 to 0.15 of an inch. The total length is generally about one inch, though it is not uncommon to find specimens of nearly twice that length. The thickness rarely exceeds 0.04 inch. Cells rhomboidal, with acutely-elliptical apertures, arranged in intersecting diagonal lines, the regularity of which is sometimes interrupted along the narrow, but distinct nonporiferous margin, where they are slightly larger than over the central portions of the frond, and have a tendency to form

longitudinal series. For a short distance above the pointed basal termination the zoarium is sub-cylindrical, and the cell apertures, being extremely elongated and apparently confluent, give this portion the appearance of being finely striated. Measuring diagonally, eleven cells occur in the length of 0.1 inch; transversely sixteen, and longitudinally six, occupy the same space.

This form takes the place of P. (*Escharopora*) *recta*, Hall, in the western exposures of the Trenton group. It is quite rare in Kentucky and Tennessee, but common in Minnesota. If I am right in my identification, it also occurs in the lower beds of the Cincinnati group (Utica shale?) in Ohio. Its geological and geographical ranges are therefore quite extended, and make it desirable that it should be held as distinct, although it is, unquestionably, very closely allied to both *P. recta* and *P. falciformis*, Nicholson. It is narrower and generally smaller than either of those species, while its nearly straight form and more acute basal termination will serve to distinguish it from the latter. The type specimens of *P. recta* are sub-cylindrical, but should this peculiarity prove to be due to extreme age, then the points of difference between the three forms would be reduced to less than specific importance, in which event I should classify them as varieties of the same species.

The genus *Ptilodictya* as defined by me, naturally divides into two groups: (1) the section containing the type species, *P. lanceolata*, Goldf., in which the cells have a plumose arrangement; and (2) another section containing the three species or varieties in question, in which the cells are arranged in intersecting diagonal series. . The first or typical section of the genus commences its existence near the top of the Cincinnati group, when the second section has become about extinct, and is best represented in Upper Silurian deposits. That its species are, however, direct descendants from those of the second section, cannot be doubted; *P. plumaria*, James, (as fig. by Ulrich), and *P. magnifica*, S. A. Miller, being clearly transitional forms. Should it become desirable to separate the two groups, Hall's genus *Escharopora* would include the second section.*

* The Lower Helderberg species referred to, *Escharopora*, by Hall are unequivocal members of the typical section of *Ptilodictya*.

Formation and locality: A common species in the Trenton shales, at Minneapolis, and other localities in Minnesota. It also occurs in the Trenton limestone of Kentucky and Tennessee.

Register No. 5929.

ARTHROPORA SIMPLEX, n. sp.

Zoarium jointed, segments fragile, unbranched, acute-eliptical in transverse section, from 0.4 to 0.7 inch long, from 0.04 to 0.07 inch wide and not ceeeding 0.04 of an inch in thickness. The first segment is sometimes irregularly branched, but that condition does not appear to be normal. The base of this joint is obtusely pointed and striated, the striae extending above the articulating shoulder one-tenth of an inch or more. The extremities of the succeeding segments are smooth or faintly striated, and slightly swollen. Zooecial apertures, of the younger segments, with the margin distinctly elevated so as to leave a narrow interstitial sulcus between them. Their arrangement is very regular in transverse and intersecting diagonal series; transversely, seven occur in 0.05 inch; diagonally, five occupy the same space; width of interstitial space less than the shortest diameter of the apertures. Non-poriferous margin narrow und obliquely striated. On the older and especially the first segments, the cell-apertures are smaller and circular, and the width of the interstitial spaces from one to three times their diameter, the non-poriferous margin wide, and the whole inter-apertural space marked with fine, flexuous, and faintly granular striae.

In tangential sections the cells are oval, thick-walled, and each surrounded by one or two rows of very minute tubuli.

On account of the condition of the specimens, both the vertical and transverse sections are unsatisfactory.

This species clearly belongs to the genus *Arthropora*, and in the structure and appearance of its cells, differs but little from *A. shafferi*, Meek. The unbranched condition of the segments, however, will distinguish *A. simplex* from that species as well as from any other form of the genus known to me.

Formation and locality: The detached segments of this spec-

ies are very common in the Trenton shales, at Minneapolis and other localities in the state where these beds are exposed. Segments of the Trenton variety of *A. shafferi* are also, though rarely, met with.

Register No. 5933.

STICTOPORA MUTABILIS, n. sp.

Zoarium variable in size and superficial aspect. Typically, it consists of branches dividing dichotomously at intervals of 0.3 to 0.4 of an inch; width of branches varying from 0.10 to 0.18 inch; thickness of same, from 0.03 to 0.06 of an inch; edges somewhat acute, with non-poriferous margin very scant, or wanting. Cells arranged in from sixteen to twenty-five rows, between rounded and but slightly elevated longitudinal lines; walls thick, apertures small, narrow, elliptical.

In old examples the apertures are scarcely recognizable, the surface appearing as simply striated. Measured transversely, sixteen rows occupy the space of 0.1 inch; longitudinally, seven and a half or eight cells suffice to fill the same space.

Sections show that the walls are extremely thick, that they are divided into longitudinal series by straight rows of very minute but distinct tubuli, and that a variable number of the latter also occur between the ends of the cells. In transverse sections these tubuli are quite conspicuous between the median laminæ of the zoarium. In vertical sections, the spur or diaphragm occurring at the base of the thick portion of the tube walls, gives to the lower region of the zooecia the form of a semi-circle.

The above sufficiently describes the typical form of this species. The two extremes of variation may be designated, provisionally, as varieties *major* and *minor*.

Var. MAJOR, n. var.

The zoarium of this variety differs from the typical form of the species in having a more robust appearance. The branches attain a width of 0.3 inch, and a thickness of 0.12 inch. Along

the center of the branches, at rather irregular intervals, occur finely striated non-celluliferous spots, which tangential sections show to be occupied by an aggregation of the minute tubuli. The rows of cells in the neighborhood of the edges of a branch are usually directed obliquely outward.

Var. MINOR, n. var.

This variety is distinguished by its smaller size, thinner branches, and more distinctly developed non-poriferous margin. Its branches vary in width from 0.07 to 0.10 inch, while the thickness rarely exceeds 0.02 inch.

This species, as well as the two species next described, are congeneric with *Rhinidictya nicholsoni*, Ulrich. When I proposed the genus *Rhinidictya*, it was under the impression that Hall's *Stictopora fenestrata*, the type of the genus, was closely allied to his *S.? acuta*. Although I have failed in obtaining authentic examples of *S. fenestrata* for comparison, I am, nevertheless, convinced by the study of specimens identified with that species from the Chazy limestones of Kentucky and Tennessee, that I was in error, and that the species is really more nearly related to my *R. nicholsoni*. The name *Rhinidictya* may therefore be erased from the list of genera, while *Stictopora* must be re-defined and restricted so that it will cover about the same ground lately occupied by the abandoned genus. In its restricted sense, *Stictopora* is typified by *S. fenestrata*, Hall, *S. mutabilis*, Ulrich, and *S. nicholsoni*, Ulrich. The cells of *S.? acuta*, Hall, and its near ally *Ptilodictya fenestelliformis*, Nicholson, have the structure of *Pachydictya*, Ulrich, to which genus I now refer them.

In the upper shaly layers of the Kentucky exposures of the Trenton group, *S. mutabilis* is a common fossil, but the two varieties, *major* and *minor*, seem to be peculiar to the Minnesota beds. Young specimens are not readily distinguished from *S. nicholsoni*, but there is no difficulty in separating the fully matured examples, the cell walls being thicker and the branches larger and much heavier than in that species.

Formation and locality: Extremely abundant in the Trenton shales about Minneapolis, and St. Paul, Minn.

Register Nos. 5938, 5939, 5956.

STICTOPORA FIDELIS, n. sp.

Zoarium branching dichotomously at intervals of about 0.5 inch. Branches from 0.08 to 0.11 of an inch in width; thickness of same varying from 0.03 to 0.06 of an inch; edges less acute than usual; non-poriferous margin narrow. Zooecia with comparatively thin walls and slightly oblique, sub-ovate or quadrangular apertures, arranged in from nine to twelve longitudinal series, between sharp though but slightly elevated lines. Measured longitudinally, eight or nine cells occur in the length of 0.1 inch; transversely, six or seven rows occupy 0.05 inch.

In tangential sections dividing the cells just below their apertures, the cell walls are rather thick, and the tube cavities elliptical, while the longitudinal elevated lines of the surface are represented by a straight dark line. A good section will show this line to contain a series of very minute tubuli, the same as occur between the divisional laminæ of the two sides of the zoarium. At a lower level in the zoarium the cells are subquadrate near the center, and rhomboidal toward the edges of the branch; the walls are thin, the anterior one convex.

Longitudinal sections show that the tubes arise abruptly from the divisional laminæ on each side, and that their course to the surface forms an angle with the median line of about 55 deg.; the anterior side of the walls is concave in the lower portion, while the posterior side is nearly straight throughout. A complete or only partial diaphragm is occasionally developed at the termination of the concave portion of the cell wall.

This species is distinguished from *S. mutabilis* by its slightly wider cells and comparatively thin walls. The cell apertures are consequently much larger than they are in that species, being besides nearly quadrangular instead of narrow-elliptical. Sections show *S. fidelis* to be clearly distinct from, though allied to *S. nicholsoni*, Ulrich.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, Lanesboro, and other localities in Minnesota.

Register No. 5936.

STICTOPORA PAUPERA, n. sp.

Zoarium small, fragile, very slender below, where it is attached to foreign bodies by a rather dimunitive basal expansion; above this it gradually expands until at a distance of about 0.3 of an inch above the base, it has attained its mature width, varying in different examples from 0.06 to 0.09 of an inch; here also occurs the first bifurcation, the second occurring about 0.25 inch above the first, while a third division, at nearly the same distance from the second, is occasionally met with. The entire hight of the zoarium is, therefore, rarely more than one inch. The greatest thickness does not exceed 0.02 of an inch. The angle of bifurcation is about 70 degrees, and quite the same in all the specimens. Cells with small, narrow, elliptical apertures, arranged in from ten to twelve longitudinal series, between slightly elevated lines; the cells in one or two of the outermost rows are directed obliquely outward. Measuring longitudinally, nine cells occupy the space of 0.1 inch; transversely, eight rows occur in 0.05 inch. Non-poriferous margin very narrow, only recognizable in good specimens.

This species is also a common fossil in the shaly layers of the Trenton group in Kentucky, where it is associated with *S. mutabilis* and other bryozoa marking this horizon. It also occurs in the Trenton rocks of Canada. The small size of its zoarium will distinguish it from other species of the genus.

Formation and locality: Trenton shales, at Minneapolis and other localities in Minnesota.

Register No. 5935.

STICTOPORELLA? CRIBROSA. n sp.

Zoarium forming thin flattened expansions, composed of branches which inosculate at short intervals till there is produced a broad frond perforated at rythmical intervals by circular or elliptical fenestrules. Both sides of frond celluliferous and consisting of two equal layers of cells that have grown together back to back, each layer, however, preserving its own concentrically striated epithecal membrane. Fenestrules usually inclined to be elliptical, their longest diameter varying

from 0.03 to 0.10 of an inch, but the prevailing size has a diameter of about 0.06 inch. Width of branches about 0.09 inch; thickness of same, varying from 0.02 to 0.06 inch. Zooecia with subcircular or broadly ovate apertures, arranged in quite regular diagonal series, nine or ten in the space of 0.1 inch. Interstitial spaces becoming thicker with age, till the zooecial apertures are separated by a distance a little greater than their diameter. Interstitial pits numerously interpolated between all the cells. Around the fenestrules there is a band 0.02 of an inch, more or less, in width, solely occupied by them.

Tangential sections show that the polygonal boundary of the zooecia is marked by a dark line, which, the evidence at hand, is not clear enough to prove to have contained a series of extremely minute tubuli. The visceral cavity is small, ovate, or subcircular. The interstitial pits are numerous, of irregular shape and unequal dimensions, often completely filled, or only preserving a very small central cavity.

Vertical sections show that the divisional laminae are flexuous, that the tubes are at first thin-walled and prostrate, that they subsequently bend abruptly outward, and that their walls at the same time are much thickened and marked with oblique lines parallel with the form of the apertures. The interstitial pits, wherever observed, were entirely filled by a concentric deposit of sclerenchyma. No diaphragms appear to have been developed.

The cells of this, and the two species next described, in all the essential points of structure, are precisely like those of *Stictoporella interstincta*, Ulrich. The characters of the genus as typified by that species, are entirely peculiar, and bear but little resemblance to those of *Stictopora*. In fact, so far as the microscopic structure is concerned, *Stictoporella* is more nearly allied to *Ptilodictya* than to *Stictopora*, but whether the peculiarities of the genus will necessitate a removal from the family *Stictoporidae*, I am not yet prepared to assert. At any rate, the structural distinctness of the genus is firmly established by the addition of the three species in question. A most striking peculiarity is presented by these species. I refer to the great difference in the form of the zoaria, when compared

with the remarkable similitude of the internal structure. Indeed it is highly improbable that any one, giving them only a superficial examination, would have classified them as nearly related species. Sections, however, prove beyond any reasonable doubt that their relation to each other is really very intimate, although distinguished from each other by very obvious differences in their respective methods of growth.

An inosculating bryozoan has been described by Hall from the Trenton rocks of Wisconsin, under the name of *Clathropora flabellata.* The description and figures are both entirely inadequate for anything even approaching a positive identification. This style of zoarium pertains to at least three Palaeozoic genera, and the species might belong to any one of these. That the species which I have above described is distinct from Hall's species is evident. His figure represents a more robost zoarium, the branches and fenestrules being over twice as wide as those of *S. cribrosa.*

Formation and locality: Abundant in the Trenton shales at Minneapolis, Minnesota.

Register No. 5944.

STICTOPORELLA ANGULARIS, n. sp.

Zoarium dividing dichotomously at intervals varying from 0.15 to 0.30 of an inch. Branches usually about 0.08 of an inch in width; frequently they are narrower, while on the other hand, a single fragment apparently referable to this species is twice as wide. The thickness is generally about 0.03 inch, and never, so far as observed, exceeds 0.05 of an inch. Transverse section of branch elliptical, the margins being rarely acute, and usually rounded. Cells polygonal or sub-rhomboidal, with sub-circular apertures placed at the bottom of a sloping "vestibule," arranged in somewhat irregular intersecting diagonal series, nine in the space of 0.1 inch; measured longitudinally, seven and one-half cells occupy the same space. Here and there over the central portions of the branch, though never in sufficient number to constitute a conspicuous feature, may be detected an interstitial pit. On the rounded margins of the zoarium, however, they are always present.

Here they form a series on each side of the median laminae. Sometimes they are very shallow and obscured by a secondary deposit of sclerenchyma.

In tangential sections, the visceral chambers of the zooecia are oval, the interspaces thick and divided in the middle by a thin, sharply defined, dark line, marking the boundary line between adjoining cells. Each cell somewhat irregularly hexagonal. A few interstitial pits, here entirely filled by sclerenchyma, may be detected.

Vertical sections demonstrate that the tubes are at first prostrate and with thin walls. At the point of bending outward in their course to the surface, the walls suddenly become very thick and marked with oblique lines, representing the form of the campanulate aperture at previous stages of growth. Diaphragms have not been observed.

The angularity of the cell apertures sufficiently separates this species from *S. interstincta* from the Cincinnati group, while the same character, and the diagonal arrangement of the cells, will serve to distinguish it from all the species of *Stictopora* occurring in the same beds. It cannot be confounded with its much larger and nearest ally *S. frondifera.*

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, Minn., but apparently restricted to the lower portion.

Register No. 5943.

STICTOPORELLA FRONDIFERA, n. sp.

Zoarium, consisting of large, thin, irregularly branching, flabellate or undulate expansions, which are celluliferous on both faces, and have rounded and minutely pitted margins. Cells arranged more or less regularly in diagonally intersecting series nine or ten in the space of 0.1 inch. The cell apertures vary from sub-circular to sub-rhomboidal. Interstitial spaces rather thick. Interstitial pits, variously distributed among the zooecial apertures, or aggregated so as to form clusters or "maculæ." These clusters are always quite irregular in both size and distribution. Thickness of frond apparently never exceeding 0.10 inch; usually it is not more

than half that thickness. Entire hight of zoarium three or four inches.

The sections of this species are almost exactly like those of *S. angularis*, and do not require a detailed description. One of the tangential sections, however, shows clearly that the boundary line between adjoining cells is occupied by a closely arranged series of very minute tubuli. The evidence afforded by the sections of *S. angularis* and *S. cribrosa* is not sufficiently clear to allow me to assert positively that these tubuli are also present in those species, but that they are is highly probable.

Formation and locality: Rather abundant in the lower part of the Trenton shales at Minneapolis, Minn. It also occurs at Lanesboro and Fountain in Fillmore county.

Register Nos. 5945–5947.

PACHYDICTYA FOLIATA, n. sp.

Zoarium growing from an attached basal expansion into erect, thin, undulating and often palmate fronds, both sides of which are celluliferous; the hight and width may be two inches or more, though it is rare to find specimens more than one inch square; their thickness is usually about 0.05 of an inch; very old examples may attain a much greater thickness, it being in some not less than 0.13 inch. Margin of fronds acute, and always more or less distinctly non-poriferous. Cell apertures large, oval, and arranged in regular intersecting series, in which six or seven occur in the length of 0.1 inch. Measuring longitudinally (*i. e.* across their larger diameter) four or five occupy the same space. On a few specimens the zooecial apertures are surrounded by a thin rim or peristome. This feature may indicate a particular stage of development, or only an exceptional state of preservation. Inter-apertural space only moderately thick, generally smooth, it being only in rare instances that the really numerous interstitial cells can be detected at the surface. At intervals of about 0.15 of an inch the surface presents smooth spots or maculæ. Usually, these are not elevated above the general plane of the surface, but in a few cases they are rather prominent.

In vertical sections the tubes arise somewhat abruptly from the median laminæ, near which their walls are thin. The interstitial tubes are developed almost immediately, and in their lower portion are crossed by numerous very distinct diaphragms, that, as the surface is approached become entirely obsolete, or at least much obscured by a deposit of sclerenchyma. In the "maculæ" which contain only interstitial tubes, the diaphragms are decidedly vesicular. The true zooecia are crossed at intervals about equalling their diameter, by from two to four complete diaphragms. These recur at about the same level in all the tubes.

In tangential sections near the central axis, the zooecia have thin walls, are broadly ovate, and more or less completely separated from each other by a series of angular interstitial cells. Nearer the surface the walls of the tubes become thickened and ring-like, but the original boundary remains distinct as a sharply defined dark line. Within this line there is a series of extremely minute tubuli. Just below the surface of fully matured examples the "maculae" are marked with a number of series of the same kind of tubuli, while in the ordinary interspaces between the zooecia they arrange themselves into two flexuous and often interrupted lines. It is, however, only in exceptionally preserved spots that these tubuli are recognizable, they being generally represented by apparently structureless dark lines.

In good transverse sections dividing the zoarium vertically but at right angles to the direction of growth, these tubuli are very plain between the divisional laminae.

This fine species is clearly distinct from any other species of the genus known to me, while in its generic characters it is as typical of *Pachydictya* as is *P. robusta*, the type of the genus. Its foliaceous zoarium will distinguish it from all the associated species, with the exception of *Stictoporella frondifera*. That species occurs on the same slabs, and a careless collector might confound them. Still, after a little study, the differences in the size and shape of their cells will become so evident that they may be distinguished at a glance.

Formation and locality. Apparently restricted to the lower

layers of the Trenton shale, in which it is abundant, at Minneapolis, Minn.

Register No. 5948.

PACHYDICTYA OCCIDENTALIS, n. sp.

Zoarium ramose, or subpalmate towards the base, dividing above into small branches; width of branches varying from 0.13 to 0.40 of an inch. Cross section of branches acutely elliptical, about 0.05 inch in thickness centrally. Margins sharp with a narrow, smooth or finely striated, non-poriferous border. Cells arranged in longitudinal, and more or less regular intersecting diagonal series; apertures ovate, slightly longer than broad. About six cells in 0.1 inch, measured longitudinally, and eight in the same space measured diagonally. The wider specimens exhibit along the center of the branch a series of smooth and apparently solid spots, which vary considerably in size. All the examples noticed present at least one of these spots, situated just below the bifurcation of the branches.

Internal structure as in other species of the genus.

This species is closely allied to both *P. acuta*; Hall, sp., and *P. fenestelliformis*, Nicholson, sp., and is of interest, principally, because it represents an unequivocal connecting link between those species.

Formation and locality. Not uncommon in the upper layers of the Trenton shales, at St. Paul, Minn.

Register No. 5949.

PACHYDICTYA FIMBRIATA, n. sp.

Zoarium small, ramose, dividing dichotomously at variable intervals. Branches thin, rarely more than 0.02 of an inch in thickness, and from 0.09 to 0.18 of an inch in width. Non-poriferous margin, obliquely striated, very wide, extremely thin and sharp, and wavy or ruffled. Over about one-half the surface along the middle of the branches the cells are arranged in regular alternating or sub-alternating longitudinal series, in which six to seven occupy the space of 0.10 inch; measuring transversely five rows occur in 0.05 inch. The two or three

rows between these and the non-poriferous margin are not so regular in their arrangement, their apertures being, besides, separated by somewhat wider interspaces, and, usually at least, directed obliquely outward. Cell apertures broadly elliptical, longer than wide, and, in perfectly preserved examples, surrounded by a faintly elevated, thin border. Inter-apertural spaces about half as wide as the longer diameter of the cell-mouths, smooth or faintly striated longitudinally.

Internal structure as in *P. acuta*, and other species of the genus.

Good examples of this species cannot be confounded with any other species known to me, as the wavy or ruffled appearance of the wide non-poriferous margin gives them a very peculiar and characteristic aspect. In other respects the species is very closely related to *P. acuta*, Hall, and less closely to *P. occidentalis*, Ulrich.

In the higher layers of the Trenton shales at St. Paul, I have noticed a number of specimens, which, while it does not seem probable, may still prove to belong to a robust variety of this species. In these the non-poriferous margin is wide, but not wavy, and the cell-apertures smaller and narrow, while the walls or interspaces are thick and usually wider than the apertures, and more distinctly striated. The branches have an average width of 0.18 inch, and a thickness of 0.06 inch or more. Should these differences prove constant then they ought to be considered as of specific importance.

Formation and locality: Rather common in the lower part of the Trenton shales, at Minneapolis, Minn.

Register No. 5950.

PACHYDICTYA CONCILIATRIX, n. sp.

Zoarium consisting of triangular stems, celluliferous on the three concave sides, and constructed on the same general plan as *Prismopora*, Hall. Margins sharp, non-poriferous, and faintly striated. Branching takes place by the development of a non-celluliferous ridge in the centre of one of the sides, which, rising gradually, eventually forms one of the non-poriferous margins of the new branch or stem. Cell apertures sub-

circular to oval, arranged in longitudinal series in the central third of the sides, while those nearer the margins are larger and directed obliquely outward and upward. Interstitial spaces of somewhat variable thickness, usually equaling about one-half the diameter of the apertures; surface minutely granular, and where the cells have a regular arrangement, the granules form rows. Measured longitudinally, six or seven cells occupy 0.1 inch. Width of branches varying from 0.13 to 0.18 of an inch.

This very interesting and I might say prophetic species, demonstrates what I have only suspected heretofore. That is, the relationship of *Pachydictya* with the *Cystodictyonidae*. In fact, the genus lacks only the small "lip" to be a typical member of the family, and it is questionable whether this deficiency is of sufficient importance to exclude the genus.

Formation and locality. Trenton group at Cannon Falls, Goodhue county, Minnesota, where it is associated with *Phyllopora? corticosa*, Ulrich, and *Streptelasma corniculum*, Hall.

Register No. 5952.

CREPIPORA IMPOLITA, n. sp.

Zoarium large, solid, irregularly ramose, or simply nodulated. Branches from 0.2 to 0.8 of an inch in diameter. Hight from two to four inches. Cells large, and rather regularly arranged, eleven in the space of 0.2 inch. Walls thin. Apertures direct, polygonal to sub-rhomboidal, with the lower margin very slightly elevated, and showing, in good specimens, the ends of the two vertical lamellae or teeth on the inside of the aperture. Interstitial cells, always few, usually absent. When present they are gathered together so as to form small "maculae."

In tangential sections the walls are seen to be thoroughly amalgamated, and the vertical lamellae or "teeth" usually represented by two spots on one side of the tube, that are of a conspicuously lighter color than other portions of the wall. In better sections their normal appearance may be observed. This is crescentic or horse-shoe-shaped, with the ends projecting into the cell-cavity.

In longitudinal sections, the tubes are gently curved, apparently throughout their length, and crossed at remote intervals, by exceedingly thin, straight diaphragms. The walls seem to have been perforated by numerous connecting "foraminae" and are composed of rapidly alternating dark and lighter shades of sclerenchyma.

The transverse section is very nearly like the tangential; proving that the branches are not divided into differentiated "mature" and "immature" regions, but that the zoarium is really of the nature of massive or parasitic species.

This very abundant species is readily distinguished from all the associated forms, by its irregular growth and large cells.

Formation and locality: Trenton shales at Minneapolis, Lanesboro, and other localities in the state.

Register Nos. 5958 to 5962.

MONTICULIPORA GRANDIS, n. sp.

Zoarium irregularly massive and often tending to become sub-ramose. Cells polygonal, thin walled. Surface without monticules but exhibiting at intervals of 0.2 of an inch conspicuous groups of large cells, that are often nearly twice the size of those of the ordinary dimensions. Eight or nine of the smaller occupy 0.1 inch; the average diameter of those in the groups is about 1-55th of an inch.

In vertical sections the tubes proceed to the surface in straight or curved lines according to the form of the zoarium. They are provided with thin walls, and usually two, more or less closely arranged series of cystoid diaphragms, one on each side of the tube, the intervening space being crossed by an equal number of straight diaphragms.

Tangential sections show that the cells are polygonal and thin-walled; the opening left by the cystoid diaphragms is large, ovate, or sub-circular, and while it is usually lateral in position, it is not infrequently central. The angles of junction of the cells are a little thickened, and there is some evidence to show that they contained very small spiniform tubuli.

This fine species resembles in its growth the more irregular examples of *M. laevis*, Ulrich, from the Cincinnati group. The

cells of *M. grandis*, are however larger and the internal structure quite different.

Formation and locality: Fragments of this species are rather rare in the lower portion of the Trenton shales, at Minneapolis, Minn. The vertical range of the species is apparently not more than six or eight feet.

Register No. 5969.

HOMOTRYPA MINNESOTENSIS, n. sp.

Zoarium ramose, branches cylindrical or sub-cylindrical, from two to four tenths of an inch in diameter, and branching at rather long intervals, that are rarely less than one and a half inches and often more than two inches. Surface smooth, no monticules having been observed in any of the numerous examples studied. Cells of conspicuously larger size than the average are collected into groups, of which the centers are about 0.13 of an inch apart. The cells composing the groups enlarge gradually, those near the middle being about twice as large as the ordinary cells occupying the intervening spaces. Center of groups often marked by a small sub-solid or pitted space. Ordinary cells polygonal, with thin walls, and, sometimes, very oblique apertures; more commonly they are nearly direct, while in a few of the large specimens they are really so. About eleven of the smaller or ordinary cells occur in the space of 0.1 inch.

Vertical sections show that the peripheral or "mature" region is very narrow, that the tubes are long and vertical in the axial region, and that their course to the aperture forms a very gentle curve. The walls in the axial region are extremely thin and wavy. Near the surface they are appreciably thickened. Diaphragms wanting in the axial region, but present in the peripheral portion of the tubes, where they recur at intervals of from one-fourth to one tube diameter. Along the upper wall is the characteristic series of cystoid diaphragms. The obliquity of the cell-apertures and the extreme brevity of the matured portion of the tubes, render the preparation of satisfactory tangential sections very difficult. The more successful ones show that the cell walls are compar-

atively thin, that a variable number of interstitial cells is interpolated among the ordinary zoœcia, while here and there, somewhat obscure traces of the connecting foraminae may be detected.

Transverse sections show the greatly disproportionate development of the axial region as compared with the peripheral. They also show that in the axial region the tubes are provided with extremely thin walls, and that near the surface they are flattened and their size considerably reduced.

This is a true species of *Homotrypa*, and is nearly related to *H. obliqua*, Ulrich, from the Cincinnati group of Ohio, but still closer in its affinity with an undescribed species occurring in the upper half of that formation. From the first, *H. minnesotensis* is distinguished by its smooth and sub-cylindrical branches, and other less obvious, differences.

Formation and locality; Common in the Trenton shales at Minneapolis, St. Paul, Lanesboro, and other localities in the state.

Register Nos. 5970 to 5975.

HOMOTRYPA EXILIS, n. sp.

Zoarium ramose, branches slender, cylindrical, about 0.15 of an inch in diameter, and dividing at intervals of one inch or more. Entire hight of zoarium from one to three inches. Surface smooth. Cells with rounded, direct apertures, and moderately thick walls. Ten or eleven of the ordinary size occur in the length of 0.1 inch. Groups of cells, slightly larger than the average, are present, but do not constitute a conspicuous feature. Interstitial cells rather numerous, especially between the cells of the groups just mentioned. Diaphragms, wanting in the axial region, but present in the short, abruptly bent peripheral region, where the walls are also thickened, and a short series of cystoid diaphragms is developed.

At first I was inclined to regard this species as the young of *H. minnesotensis*. But this is evidently not the case, as the specimens have a more matured look than many much larger specimens of that species. The walls get thicker and the apertures more rounded than is the case in even the most matured examples of *H. minnesotensis*.

Formation and locality: Not uncommon in the lower portion of the Trenton shales at Minneapolis, Minn.

Register No. 5976.

HOMOTRYPA SUBRAMOSA, n. sp.

Zoarium sub-ramose, branches sub-cylindrical or slightly flattened, with the upper extremities rounded and expanded.—Branches varying in diameter from 0.2 to 0.4 of an inch; apparently dividing but once or twice, the entire zoarium being rarely more than one inch and a half in hight. Surface without monticules. Cells with moderately thin walls, and polygonal and direct apertures; nine or ten occupy the space of 0.1 inch. At irregular intervals the surface presents inconspicuous clusters of cells that are slightly larger than the average. Well developed spiniform tubuli occur at most of the angles of junction between the cells. They constitute a marked feature on all good specimens.

Longitudinal sections show that the tubes proceed from the axial region to the outer surface in a gentle but gradually increasing curve; that at unequal intervals several parallel convex lines of diaphragms cross the branch; that between these the diaphragms may be absent or scattered and infrequent; that the walls throughout the axial region are thin and decidedly wavy; that they are moderately thickened in the peripheral or "mature" region, and are there provided with a more or less closely arranged series of cystoid diaphragms, the extent of which, of course, depends entirely upon the age of the specimen.

In tangential sections the walls are moderately thin, the cell-cavity is sub-angular, and exhibits usually at one side the crescentic opening left by the cystoid diaphragms. The spiniform tubuli are large, and as the walls are comparatively thin, they are more striking than usual with species of the genus.

This is not closely related to either of the preceding species, but finds its nearest allies in several undescribed species of Ohio and Kentucky.

Formation and locality: Not common in the Trenton group at Minneola, Goodhue Co., Minn.

Register No. 5980.

HOMOTRYPA INSIGNIS, n. sp.

Zoarium sub-ramose, from one to two inches in hight; branches sub-cylindrical or flattened, often lobate, or throwing off short branches, the distal extremities of which are concave. Diameter of branches varying from 0.15 to 0.30 of an inch. Surface smooth, without monticules. Cells with very thin walls, and shallow apertures. These two conditions conduce to give the cell-apertures, especially those of the younger specimens, the appearance of being extremely oblique, when in fact they are but slightly so, and in old examples not at all. An explanation of this peculiarity is found in the fact that the cystoid diaphragms occur just beneath the top of the thin cell-walls, and the least wearing will remove the wall all around the cell excepting at the small posterior opening left by the cystoid diaphragms. Groups of cells of larger size than the average, occur at intervals of about 0.12 of an inch. Ten or eleven of the ordinary cells occupy 0.1 inch.

Tangential sections show that the walls are thin, that small spiniform tubuli occupy many of the angles of junction, and that the sub-circular opening or tube left on the posterior side of the cell by the cystoid diaphragms, is comparatively small, and unless sharply defined, may be overlooked.

In vertical sections the tubes in the axial region are not provided with diaphragms excepting in special zones, where they are numerous. In the peripheral region they are crowded, and although greatly resembling ordinary straight diaphragms, they are, nevertheless, of the nature of cystoid diaphragms. Their posterior portion is in most cases abruptly bent inward, but at a point so near the wall of the tube that it may be overlooked.

The distinguishing features of this species are the thin walls, the shallowness of the cells at their apertures, and the large size and number of the cystoid diaphragms. Slightly worn examples are readily identified by the peculiar obliquity of the cell-apertures, which for the reasons given in the description, appear to be very small, the larger portion of the surface being occupied seemingly by wall-substance.

Formation and localily: Rather rare in the Trenton shales near Fountain and Lanesboro, in Fillmore Co., Minn.

Register Nos. 5977 to 5979.

HOMOTRYPELLA, nov. gen.

Zoaria somewhat irregularly ramose, rarely frondescent; monticules wanting; small maculae of interstitial cells usually present. Zoœcia small, with moderately thick walls and cystoid diaphragms. Interstitial cells numerous, often completely isolating the true zoœcia; diaphragms straight. Spiniform tubuli very numerous, of medium size, and frequently encroaching upon the visceral cavity of the zoœcia.

Type: *H. instabilis*, n. sp.

The above characters are represented in at least six species now before me. They are all new to science with the exception of one, a description of which has been published by me under the name of *Chaetetes grameliferus** It is a common species in the Trenton shaly limestones of Kentucky. Of the remaining five species, three occur in the Cincinnati group of Ohio, one in the same formation in Illinois, and the last in the Trenton shales of Minnesota. Judging from the aggregate of characters, the position of the genus is intermediate between *Peronopora*, Nicholson, and *Atactoporella*, Ulrich, on the one side, and *Homotrypa*, Ulrich, on the other. The genus is also related to *Leioclema* and *Batostomella*, Ulrich, but differs in the tabulation of the zoœcia.

HOMOTRYPELLA INSTABILIS, n. sp.

Zoarium ramose, branches rounded, sometimes irregularly nodular or lobate, and varying in size, some being slender and not more than 0.18 of an inch in diameter, while others are much heavier and in several instances exceed 0.3 inch in diameter. Superficial aspect of cells presenting a variety of appearances depending upon the age and preservation of the specimens. In well preserved younger examples the cells are comparatively thin-walled, subcircular, and surrounded by slightly smaller, angular, interstitial cells. When a little worn, and this is especially the case in the larger specimens, the walls appear very thick, the cell-apertures, sub-circular or irregularly inflected, and the interstitial cells scarcely recognizable as such; or the visceral cavities of the latter are filled solid, and the observer is apt to

*Jour. Cin. Soc. Nat. Hist. vol. 2, p. 128.

suppose that they are absent. In well preserved and fully matured examples the interstitial cells are again obscured by the spiniform tubuli. These are rather small but numerous, there being two or three to each cell. Small "maculae" of interstitial cells, usually appearing as non-poriferous smooth spots, may occur at intervals of about 0.12 of an inch. Eleven or twelve of the true zoœcia occupy 0.1 inch; the diameter of their apertures is about $\frac{1}{200}$th of an inch.

In tangential sections the polygonal line of contact between the cells is nearly always sharply defined. The interstitial cells are numerous and of unequal size, though usually of much smaller size than the true zooecia. The walls of both kinds of cells are of equal thickness, the portion of same immediately surrounding the visceral cavity, being also of darker hue than beyond. Visceral cavity of true zoœcia often sub-circular or ovate, but more commonly with an irregular outline, due to the encroachment of the conspicuous spiniform tubuli. These are nearly or quite as large as the interstitial cells, and differ from them only in having their central portion entirely filled by a dark deposit of sclerenchyma. Their number varies from one to three times that of the true zoœcia. At unequal intervals the section presents small irregular aggregations of the interstitial cells. The cystoid diaphragms are not present in these sections excepting when they are prepared from very young examples or cut the zoarium at a deep level.

In the axial region of a vertical section the walls of the tubes are thin and undulated, the diaphragms straight and remote, and the direction of the tubes, from their point of origin to where they enter the "mature" or peripheral region, forms an angle of about twenty degrees with the imaginary central axis of the branch. In the peripheral region this angle is gradually increased until the maximum of about seventy-five degrees is attained. At the same time the walls are much thickened, and the numerous interstitial cells and spiniform tubuli are developed. The former are distinguished from the true zoœcia by the fact that they are intersected by straight, complete diaphragms only, while the true zoœcia have the superior wall lined in a portion of their length by a series of cystoid diaphragms. These structures number from eight to fifteen in each tube, and are developed only in the

region intervening between the fully matured peripheral and the immature axial region. Beyond them the diaphragms are crowded and essentially horizontal. In the interstitial tubes they are scarcely more crowded than in the true zoœcia, and, especially in the outer portion, more or less obscured by sclerenchyma.

It is highly probable that the above description embraces more than one species. Both extremes in size present, besides some important differences in internal structure. These have not been noted in the descriptions of the sections, the character of what I regard as the typical form alone being given. Until I can give more time to the examination of the relative importance of the variations noticed, I have deemed it, in the meantime, advisable to describe them under one specific name.

Formation and locality: Rather common in the Trenton shales, at Minneapolis and other localities in the state of Minnesota.

Register Nos. 5025, 5981 and 5982.

PRASOPORA SIMULATRIX, n. sp.

Zoarium discoid when young, hemispheric or depressed subconical when adult; base more or less concave, and covered with a concentrically striated epitheca; upper surface celluliferous; hight of zoarium varying from one-fourth of an inch to two inches; diameter from one-half of an inch to four inches. Zoœcia or true cells with sub-circular apertures, and comparatively thin interspaces that are occupied by rather numerous small angular interstitial cells. Groups of cells of a slightly larger size than usual occur at intervals of 0.15 inch, measuring from center to center. Between these the interstitial cells are always more numerous than elsewhere, and not infrequently form a small "macula" in the central portion of the clusters. In the spaces between the "maculæ" the interstitial cells might be overlooked, although as shown by sections, they are really numerous. Diameter of apertures of one of the ordinary cells about 1-105th of an inch, while nine of the same occupy 0.1 inch.

In tangential sections the true zoœcia are sub-circular, or more strictly speaking, polygonal, the walls very thin, and the

visceral chamber invariably intersected by the crescentic edge of the cystoid diaphragm. The opening left by the cystoid diaphragms is either lateral or sub-central, but more commonly the former. The zooœcia are in contact only at limited points, and the interspaces between them are filled by the small interstitial cells. These are somewhat variable in number, and greatly so in size, but always decidedly angular. They are furthermore, collected at intervals into small sub-stellate groups or "maculæ."

Vertical sections show that the cystoid diaphragms form a continuous series on one or both sides of the tubes, according as they extend all around the circumference, or take in only a portion of the same, while an equal number of straight diaphragms crosses the remaining portion of the tube. The interstitial tubes are crossed by about twice as many simple horizontal diaphragms. The cell-walls throughout are very thin.

This species in many respects closely resembles *P. Selwyni*, Nicholson, but they differ so decidedly in the internal structure that I must regard them as distinct. In the true, or what Dr. Nicholson calls the typical form of *P. Selwyni*, the cystoid diaphragms are isolated, and never form connected series as they do in *P. simulatrix*, *P. grayæ*, Nich., and Eth. jr., and a number of other species. A similar and even more marked isolation of the cystoid diaphragms pertains to *P. oculata* and *P. affinis*, described by Foord from the Trenton of Canada. None of the Canadian species of the genus, so far as known, occur in the Trenton rocks of Kentucky and Tennessee, nor in the equivalent strata of the northwest, and it is singular that all the American species have the cystoid diaphragms in more or less crowded continuous rows, while in the Canadian species the isolated condition of these structures prevails. Nicholson's variety *hospitalis*, of *P. selwyni*, is more nearly related to *P. simulatrix*, but differs in having spiniform tubuli, and an attached zoarium. But why *P. hospitalis* should be called a variety, is more than I can understand. The parasitic habit of growth, spiniform tubuli, and mode of tabulation distinguish it, at least specifically, from *P. selwyni*.

Formation and locality: In the Trenton shales, but apparently not common in any locality in the state. It has been found at Minneapolis, St. Paul, Lanesboro and Mantorville. In the shaly

limestones of the Trenton in Kentucky and Tennessee the species is exceedingly common, and grows to a larger size than the Minnesota specimens.

Register Nos. 4041, 5124, 5532, 5986 to 5988.

PRASOPORA CONOIDEA, n. sp.

Zoarium depressed, conical; base rather deeply concave, and covered with a concentrically wrinkled epitheca; hight varying from 0.2 to 0.6 of an inch; diameter from 0.4 to 0.8 of an inch. Upper surface celluliferous and exhibiting, at intervals of 0.12 inch, more or less prominent monticules, mainly occupied by groups of cells larger than the average. The summits usually appear to be sub-solid, but sections show that this portion of the monticules is occupied by an aggregation of small interstitial cells. Zoœcia with sub-circular or polygonal apertures; ten of the ordinary size occur in the length of 0.1 inch.

Both the vertical and tangential sections resemble those of *P. simulatrix* to a marked degree. In fact they are identical in all respects. excepting that the tangential section of *P. conoidea* shows a few spiniform tubuli, and usually fewer interstitial cells, though the maculæ between the groups of large cells are generally of greater dimensions than we find them in such sections of *P. simulatrix*. As the differences in internal structure are so slight, the external characters, such as the form of zoarium and monticules, must mainly be relied upon in distinguishing the two species. In nearly one hundred specimens of *P. conoidea* examined, the small size, sub-conical form, more or less developed monticules, and concave base, are very persistent characters, and sufficient to distinguish specimens of the two species at a glance.

Formation and locality: At Oxford mills near Cannon Falls, Goodhue county, associated with *Phyllopora? corticosa*, Ulrich, *Streptelasma corniculum*, Hall, and *Pachydictya conciliatrix*, Ulrich.

Register No. 3483.

PRASOPORA CONTIGUA, n. sp.

Zoarium hemispheric, base flat or slightly concave, usually one-

half or three-fourths of an inch in diameter, and rarely one inch or more; a single specimen, apparently belonging to this species, is, however, about four inches in diameter. Zoœcia with thin walls and polygonal apertures; nine of the ordinary size occupy 0.1 inch. Groups of cells of somewhat larger size than usual occur at intervals of 0.15 inch. Their diameter rarely exceeds $\frac{1}{10}$ of an inch. Interstitial cells scarcely detectable at the surface.

Tangential sections show that the zoœcia are polygonal, and thin-walled; that they are in contact excepting at their angles, where one or two small interstitial cells are wedged between them; that in the centre of the groups of large cells there is usually a small aggregation of the interstitial cells; and that a few spiniform tubuli are developed. The tubular opening left by the cystoid diaphragms is of medium size, and more often excentric than central in its position within the tube cavity.

Vertical sections are remarkable mainly, because they exhibit a marked decrease in the number of interstitial cells, when compared with other species of the genus.

The superficial aspect of the celluliferous surface of this species is very much like that of species of *Monotrypa*, and to a less degree, also resembles that of *Prasopora simulatrix*. Still, after a little practice they are readily distinguished by the thinner cell-walls of *P. contigua*. Tangential sections will immediately prove their distinctness. The same species, very slightly modified, occurs in the Cincinnati group at Cincinnati, Ohio, about three hundred feet above the Ohio river.

Formation and locality: In the Trenton shales at localities in Goodhue and Dakota counties.

Register Nos. 5301, 5989, 5534.

DIPLOTRYPA INFIDA, n. sp.

Zoarium discoid, sometimes approaching hemispherical. Base flat or slightly concave; hight from one to three tenths of an inch; diameter from one-half an inch to one inch. Zoœcia varying in form from polygonal to sub-circular, the shape depending upon the number and size of the interstitial cells. In some specimens these cells are almost certain to be overlooked, as the

zoœcia are angular and seemingly in perfect contiguity. In others the interstitial cells are large and very obvious between the true zoœcial apertures, which in these specimens are circular. At intervals of 0.15 inch, measuring from center to center, there are conspicuous clusters of zoœcia of larger size than usual, the diameter of the apertures of the ordinary cells being only about 1–110th of an inch, while that of those forming the clusters varies from that size to 1–65th inch. Nine or ten of the ordinary zoœcia occupy the space of 0.1 inch.

Tangential sections vary somewhat in the appearance they present, according to the depth below the surface at which they divide the zoarium. When taken just below the surface of a specimen with angular zoœcial apertures the interstitial cells, although numerous, are small and wedged in between the zoœcia, the walls of the latter being largely in contact with each other. Spiniform tubuli of moderate size are developed at most the points of junction between the zoœcia. At a deeper level the zoœcia are sub-circular, and from their shape alone are necessarily in contact with each other only at limited points. The interstitial cells are, moreover, much larger, and somewhat more numerous than they are in the region just described.

In vertical sections the tubes are everywhere perpendicular to the basal epithecal membrane. Their walls are not excessively thin, being slightly thicker than is usual with species of the genus. The interstitial tubes are more conspicuous in the lower half of the section than in the upper where the true zoœcia are often in contact. That condition is less frequent in the lower region. The diaphragms in the zoœcia are numerous but extremely variable, some being horizontal, some more or less oblique, while others are curved and overlapping, and occasionally present the appearance of short irregular series of cystoid diaphragms. The diaphragms in the interstitial tubes are crowded and horizontal. The thick-walled spiniform tubuli are rather conspicuous in these sections.

It is difficult to determine whether this species has more affinity with *Prasopora* or *Diplotrypa*. The only important character distinguishing the two genera is found in the cystoid diaphragms. These structures are not present in the typical species of *Diplotrypa*, but in *D. regularis*, Foord, the diaphragms are usually

oblique and often curved, while *D. infida* goes but a step farther in having some of them overlap like cystoid diaphragms. In tangential sections, however, the appearances presented are more like those of *Diplotrypa* than *Prasopora*, the interstitial cells being somewhat larger than is usual in the latter genus, and the very striking appearance of the cystoid diaphragms of *Prasopora*, when cut transversely, is either absent or occurs only here and there in isolated instances. So, while the species is undoubtedly intermediate between the two genera, the greater affinity seems still to be with *Diplotrypa*.

Formation and locality: In the Trenton shales of Goodhue and Fillmore counties.

Register No. 5993.

ASPIDOPORA PARASITICA, n. sp

Zoarium adhering to foreign bodies, upon which it forms thin sub-circular patches usually about one-half an inch in diameter, and from one to three hundredths of an inch in thickness. In a few instances noticed, the shell upon which the zoarium had commenced its growth proved too small, and the under side of the colony, where it projects beyond the encrusted body, is covered by a faintly wrinkled epitheca. Zoœcia with oval or circular apertures, moderately thin walls, and a regular arrangement in curved series around groups of cells larger than usual; about ten of the cells in the spaces between the "clusters" occur in 0.1 inch. Interstitial cells numerous, but, as a rule, they are obscure at the surface and readily overlooked. Spiniform tubuli rather numerous and recognizable at the surface of all well preserved examples.

Vertical sections show the extreme tenuity of the zoarium. The zoœcia are at first somewhat prostrate, but they soon bend upward and open at the surface with direct apertures. One large cystoid diaphragm is, apparently always present at the bottom of the cell, and I do not doubt that with age, a short series of them is developed. The interstitial tubes expand very rapidly above their point of origin, which is just above the basal or epithecal membrane. They are crossed by from five to ten close-set horizontal diaphragms.

In tangential sections the zoœcia are sub-circular or oval, and in contact with each other at two, three, or four points, the sub-rhomboidal or irregular spaces intervening being occupied by the interstitial cells. Walls of zoœcia thin. Spiniform tubuli of moderate size occur at nearly all the points of contact between the zoœcia.

The parasitic habit of the species distinguishes it from all other species of the genus known to me. Otherwise it is closely allied to both *A. newberryi*, (*Prasopora newberryi*, *Nicholson*) and *A. calycula* (*Diplotrypa calycula*, *Nicholson*), from the Cincinnati group of Ohio. I know of no associated species sufficiently resembling it to require a close comparison.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, St. Paul and other localities in the state of Minnesota

Register Nos. 5994, 5995.

AMPLEXOPORA WINCHELLI, n. sp.

Zoarium irregularly ramose; branches cylindrical, but oftener more or less flattened, and varying in diameter from 0.2 to 0.35 of an inch. Entire hight of zoarium, apparently, not more than two inches. Monticules are absent, though, now and then, the surface is very slightly undulating. The cells are small, thick-walled, of nearly equal size, rather irregular in their arrangement, and when well preserved the walls show at the angles of junction the elevated points of the spiniform tubuli. Interstitial cells sparingly developed, or wanting. On an average nine cells occupy 0.1 inch.

In longitudinal sections the tubes in the "immature" or axial region are thin-walled, and crossed by complete diaphragms from one to three tube diameters distant from each other. In the peripheral or "mature" region they bend outward rather abruptly, and proceed directly to the surface. As they enter this region their walls become much thickened; in some sections this thickening of the walls is extreme. As usual, the diaphragms are also more numerous, often crowded, and not infrequently exhibit a tendency to coalesce with each other.

Tangential sections exhibit considerable variation in the thick-

ness of the cell walls. This variability is due, apparently, to the different ages of the specimens sectioned. In the younger examples the thickness of the walls equals about one third of the diameter of the cell-cavity, while in very old specimens the cavity may be reduced by additional deposits of sclerenchyma to a diameter equaling scarcely more than one-third the thickness of the walls. The boundary line between adjoining cells is distinctly defined by a dark line. Each of the angles, and often points between them, are occupied by a spiniform tubulus of medium size. When in a good state of preservation the central lucid spot of the spiniform tubuli is seen to be larger than usual with species of this genus.

In some respects this species is related to the *A. canadensis*, described by Foord from the Black River and Trenton formations of Canada. But the branches of that species are much larger, while the thickness of the cell walls does not approach that observed in matured examples of *A. winchelli.* They also differ in the tabulation and direction of the tubes, as well as in the size and number of the spiniform tubuli. Associated with this is a common species having all the characters, save one, ascribed to *A. superba,* Foord. In the Trenton rocks of Canada the surface of that species presents small monticules. These are wanting in the Minnesota specimens, but as the presence or absence of monticules, especially in the genus *Amplexopora,* is of small importance, I think I am justified in regarding them as specifically identical with the Canadian specimens. The larger cells and more robust zoarium of *A. superba,* readily distinguish that species from *A. winchelli.*

The specific name is given in honor of Prof. N. H. Winchell, the accomplished chief of the survey.

Formation and locality: Common in the Trenton shales at Minneapolis, Minn.

Register Nos. 5999 *to* 6001.

BATOSTOMA FERTILIS, n. sp.

Zoarium large, varying from ramose to sub-frondescent, or palmate; branches usually more or less compressed, and varying in thickness from 0.2 to 0.4 inch; width of same, from 0.3 inch

to 1.2 inches; hight, so far as observed, not exceeding 2.5 inches. Cell-apertures varying from polygonal to circular, according to the thickness of the walls, and the size and number of the interstitial cells. In some specimens having sub-circular cells and the apertures surrounded by a slight rim, the interstitial cells are very numerous in the depressed inter-zooecial spaces. This condition is, however, not common, yet in no instance have I found it difficult to recognize the interstitial cells, as they are more or less numerous in all the specimens. Spiniform tubuli numerous but very small, and only rarely presenting their superficial terminations. At intervals of about 0.12 inch, the surface usually presents small sub-stellate maculae, around which the zooecia are generally somewhat larger than usual. Seven or eight cells of the ordinary size occupy 0.1 inch.

In vertical sections the tubes have thin, and somewhat irregularly fluctuating walls in the axial region of the zoarium. They proceed toward the surface in a gentle curve, and as they near the same, their walls become appreciably thickened, but never to any great extent. The interstitial tubes are abruptly developed, and constricted at the points where they are crossed by the diaphragms. These occur at but slightly shorter intervals than those in the peripheral regions of the true zooecia, where they are separated by distances equaling from one-third to one tube diameter. In the axial region the diaphragms are either very remote, or more commonly, are entirely absent.

Several tangential sections show that the zooecia are always more or less angular; that they have thin walls, and often are in contact with each other on all sides, but usually more or less separated by angular interstitial cells; that the interstitial cells are especially developed, both in size and number, at rhythmical intervals corresponding to the small "maculae" observed at the surface; and that the spiniform tubuli, though numerous, are small and only faintly defined, so that, unless searched for, they may be overlooked.

This species is not closely related to either of the other species of the genus now known from the Trenton formation of Minnesota. Both *B. ottawaensis*, Foord, and *B. irrasa*, Ulrich, have, when matured, very thick-walled cells, while those of *B. fertilis*, are, except in rare instances, comparatively thin-walled. Their

internal characters are too distinct to require comparison. A more closely allied species occurs in the upper beds of the Cincinnati group of Ohio, and another in the Utica slate of Canada, and the equivalent formation in Kentucky. As no descriptions of these species have yet been made public, it would be useless to institute comparisons.

Formation and locality: Abundant in the lower half of the Trenton shales at Minneapolis and other localities.

BATOSTOMA IRRASA, n. sp.

Zoarium, consisting of small, sub-cylindrical or compressed, and frequently divided branches, usually less, rarely a little more, than 0.3 inch in their greatest diameter. Cells with polygonal apertures and thin walls when young, and with smaller, oval or sub-circular apertures, and thick walls in the fully matured examples; seven or eight occur in the length of 0.1 inch. The spaces between the cell-apertures appear solid in the mature specimens, but in some of the younger examples, with also angular zooecial apertures, a variable number of irregularly shaped interstitial cells may be recognized. Spiniform tubuli numerous, two or more to each cell; they are large and constitute a conspicuous external feature of mature examples. In such specimens, certain small, sub-stellate, smooth spots are most distinct.

Vertical sections show that the tubes have thin and irregular fluctuating walls in the axial region, but less thin than usual; that in this region they are crossed by remote complete diaphragms; that near the surface the diaphragms are nearly straight, but often incomplete and less than a tube diameter apart; that their course from the point of origin to their apertures forms a nearly equally curved line; that their walls become but slightly thickened until just below the surface, where the apertures are contracted by a deposit of sclerenchyma, and many of the walls separate to make room for some very short interstitial tubes or cells, the latter are usually filled by a secondary deposit.

The matured region being very shallow, it is difficult to prepare

satisfactory tangential sections. A very good one shows that the cells just below the surface have thick ring-like walls, that their form is oval or sub-circular, and that they may be in contact or separated by very irregular and unequal interstitial cells, which have been more or less completely filled by an homogeneous deposit of light-colored sclerenchyma. The spiniform tubuli are numerous, and, as is usual in this genus, have the central cavity large and distinct. Where the section cuts the zoarium at a deeper level we observe that the cells were angular and mainly in contact with each other, the interstitial cells being as yet small; while the spiniform tubuli are hardly perceptible.

This very neat species is quite distinct from any heretofore described. In having a few incomplete diaphragms it resembles *B. ottawaensis*, Foord, but otherwise they are quite different. In size of zoarium it approaches *B. implicata*, Nicholson, but the cell walls are not inflected by the spiniform tubuli as in that species, nor do they resemble each other in their vertical sections.

Formation and locality: In the lower portion of the Trenton shales at Minneapolis, Minn. In the excavation for the St. Paul and Northern Pacific bridge pier on the eastern bluff of the river, these layers were exposed and many interesting bryozoa were obtained from them. Of these *Pachydictya foliata*, *Stictoporella angularis*, and *S. frondifera* occur on the same slabs of shale with *Batostoma irrasa*.

CALLOPORA UNDULATA, n. sp.

Zoarium ramose, branches small, slender, about 0.12 of an inch in diameter, and dividing dichotomously at intervals of about 0.4 inch or more. Surface with rounded monticules, that usually coalesce laterally and form, more or less complete, transverse ridges, five in 0.4 of an inch. In some specimens the monticules are separate, while in a few they are almost obsolete. Zoœcia with moderately thin walls, and sub-angular apertures. Interstitial cells comparatively few, very small, readily overlooked. Zoœcial apertures nearly equal in size over all portions of the surface; nine occur in the space of 0.1 inch.

In tangential sections the zoœcia are oval or sub-angular, the

walls of moderate thickness, and preserving the original line of junction between adjoining cells. Interstitial cells though small, are yet larger and more numerous than one is led to believe from an examination of the exterior. Nearly all the angles of junction between the true zoœcia are occupied by them.

Vertical sections present no marked differences from other species of the genus. In fact the species of *Callopora* are remarkably persistent in their internal structure, and the points mainly to be relied upon in distinguishing the species are external. As usual the tubes are closely tabulated for a short distance above their point of origin in the axial region of the zoarium. Subsequently the diaphragms are remote, and it is only just below their apertures that they are again numerously developed. The interstitial tubes are short and closely tabulated. The tube walls are some what thinner throughout the zoarium than is usual.

Transverse sections present the characteristic features of the genus. In the axial region the zoœcia are of two sizes, the larger being sub-circular or polygonal, and, from their shape, in contact with each other only at limited points. The intervening spaces are occupied by more angular cells in every stage of development so far as size is concerned. At the periphery the tubes are cut longitudinally. Here the walls are of moderate thickness, and divided in the center by a dark line. But few interstitial cells are to be seen in this style of section.

The rounded, transverse ridges or annulations will distinguish this species from any other form of the genus described. When these are, as is sometimes the case, but faintly developed, care must be taken in distinguishing it from a small undescribed species of *Monotrypella*, occuring in the same beds.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis Minn.

CALLOPORA INCONTROVERSA, n. sp.

Zoarium ramose; branches smooth, sub-cylindrical, from 0.18 to 0.30 of an inch in diameter, and dichotomously divided at intervals of about 0.5 inch. Zoœcia with oval or sub-circular, rarely polygonal apertures, and rather thin walls. Small groups of slightly larger size than the average are occasionally present.

These are never conspicuous and occur at irregular intervals. Eight or nine of the usual size occupy 0.1 inch. Some of the apertures preserve the opercula. The central perforation is larger than usual and surrounded by a distinct rim. Interstitial cells generally numerous, but varying somewhat in distribution and number in different specimens.

Tangential sections show that the zoœcia are nearly circular or broadly elliptical, that their walls are of moderate, but somewhat variable thickness, and that, usually, they are in contact with each other at as many points as their rounded form will admit. The interspaces are occupied by the interstitial cells. At unequal intervals a few of the latter form small irregular groups. The true zoœcia in the immediate vicinity of these groups are also of somewhat larger size than the average.

In vertical sections the tubes form a gradual but rather short curve to the surface. The tabulation and appearance of the proximal ends of the true zoœcia, are so much like that of the interstitial tubes that it is reasonable to believe that their functions were also alike. From the point of origin till it has attained nearly its mature size, the tube is crossed by twelve or more closely and regularly arranged diaphragms; when suddenly they cease. Near the surface they again become numerous but irregular, while in the intervening portion they occur only at remote intervals, or are entirely absent.

When in a good state of preservation, even small fragments of this species are readily recognized by the characters above described. In the worn condition they may be confounded with an associated species of *Homotrypa*. Sections will, of course, immediately distinguish them.

Formation and locality: Rather rare in the Trenton shales at Minneapolis, Minn.

TREMATOPORA PRIMIGENIA, n. sp.

Zoarium ramose; branches sub-cylindrical or compressed, from 0 06 to 0.12 of an inch in diameter, and dichotomously divided at intervals of 0.2 inch or more; the attached basal expansion is comparatively large, and usually supports several branches;

entire hight of branches apparently not exceeding one inch. Superficial aspect of zoœcia varying with age. In the younger examples the apertures are oblique, with only the posterior border elevated, and the interstitial spaces of less width than the diameter of the apertures. With age the apertures become somewhat smaller, sub-circular, and more direct, and the peristome or rim nearly equally elevated all around, while the interstitial spaces are widened, till in some examples they are equal to twice the diameter of the zoœcial orifice. Most specimens present irregular spots or maculæ, where the zoœcia are of larger size than usual and separated by wide interspaces. In some the maculæ form circumscribed, seemingly solid, spots, thus furnishing a conspicuous feature to the surface; while, on the other hand, in a few, otherwise typical examples, only traces of them can be detected. On the whole, therefore, the arrangement of the zoœcia is irregular. Diameter of apertures varying from $\frac{1}{260}$th to $\frac{1}{175}$th of an inch. From ten to fourteen occupy the length of 0.1 inch, but twelve is the prevailing number. As usual with species of the genus, the orifices of the interstitial cells are closed by a membrane. Sections prove them to be numerous, and that they more or less completely isolate the zoœcia. Spiniform tubuli very small and generally worn away.

Sections present the usual characters of the genus as restricted by me.* In the final report on the palæontology of the state, they will be fully described and illustrated. In this communication it will suffice to state that all the essential characters of *Trematopora* are represented.

The large basal expansion, small branches, rounded cell apertures, and the somewhat depressed, wide, and smooth interstitial spaces, and "maculæ," are the distinguishing features of the species.

Formation and locality: Common at Minneapolis and other localities of the state, in the Trenton shales.

Register Nos. 6010, 6011.

TREMATOPORA ORNATA, n. sp.

The zoarium of this species, in its growth and general appear-

* Jour. Cin. Soc. Nat. Hist., vol. vi, p. 257.

ances, so closely resembles that of *T. primigenia*, that a detailed description will scarcely be deemed necessary. They differ as follows: The zoœcia of *T. ornata* are more closely, as well as more regularly arranged, the interstitial spaces narrower and more depressed, and the "maculæ" absent. When in a good state of preservation, the elevated border around the apertures is surrounded by a closely arranged series of granules or blunt spines, which impart a very ornamental appearance to the magnified surface. A variable number of somewhat larger spines also occurs in the interstitial spaces. The greater development of the spines is the most obvious and important difference, and when preserved, should distinguish the two species immediately.

I am not entirely satisfied that the generic affinities of the species have been correctly determined. Future investigations may prove it to belong to *Bythopora*, Miller.

Formation and locality: Rather rare. Associated with the much more abundant *primigenia*, at Minneapolis, Minn.

BYTHOPORA HERRICKI, n. sp.

Zoarium ramose, less than two inches in hight; branches slender, cylindrical, from 0.03 to 0.10 of an inch in diameter, and divided dichotomously at intervals varying from 0.3 to 0.5 of an inch. Zoœcia arranged in somewhat irregular longitudinal series, with thick walls, narrow and very oblique apertures, the upper end of same being drawn out and shallow. Interspaces or walls sometimes channeled, or with elongate shallow pits. Measured longitudinally about seven cell-apertures occur in 0.1 inch; transversely eight rows occupy 0.05 inch. Spiniform tubuli small, few, and but rarely preserved.

The internal structure of the species has not been determined satisfactorily, being obscured, or entirely destroyed by crystallization. Still the superficial characters of the cells are so much like those of *B. fruticosa*, Miller, the type of the genus, that I feel no hesitancy in referring the Minnesota specimens to the same genus. When in a good state of preservation, *B. herricki* can not be confounded with any of the associated species, the extremely narrow cell-apertures being quite distinctive. The

branches are, besides, more slender and cylindrical than those of *Trematopora primigenia* and *T. ornata*.

Formation and locality: Fragments of this species are quite common in the Trenton shales of St. Paul and Minneapolis, Minn.

Register Nos. 6012, 6013.

MONOTRYPELLA MULTITABULATA, n. sp.

Zoarium consisting of irregularly divided, cylindrical or slightly compressed branches, varying in diameter from 0.15 to 0.4 of an inch. Surface usually presenting more or less elevated monticules, at intervals of 0.1 inch, measuring from center to center. In the Minnesota specimens the monticules are often absent, and instead, we find groups of cells of larger size than ordinary. Zoœcia polygonal, eight or nine in the space of 0 1 inch; walls rather thin. Interstitial cells not to be detected at the surface. Spiniform tubuli wanting.

In tangential sections the zoœcia are seen to be regularly polygonal, in contact at all points of their circumference, and provided with only moderately thickened walls. Further, each is separated from the other by a distinct boundary line, which is often conspicuously thickened where three or more cells come in contact, so as to resemble spiniform tubuli. Here and there occurs a small cell whose nature is doubtful. They are most probably abortive or young, though they may prove to be interstitial.

Vertical sections show that the tubes are provided with an excessive number of diaphragms. In the axial region these structures recur at intervals varying from one to three tube-diameters, while in the peripheral portions of the tubes they are extremely crowded. Many of the diaphragms in this region are slightly curved, and they often join with one another. The duplex character of the walls is preserved throughout the "mature" region, where they are also appreciably thicker than in the axial region. In a few instances the section passes through some small tubes, which present the usual appearance of interstitial tubes.

The distinguishing feature of the species is found in the extremely numerous diaphragms. The thin polygonal cells, and absence of spiniform tubuli, will separate it from the associated ramose bryozoa.

Formation and locality: This is a common species in the Trenton formation of Kentucky. It also occurs rather abundantly in the shales at Minneapolis, Lanesboro, and other localities in the state.

DISTRIBUTION OF SPECIES.

	Cincinnati group.	Trenton shales.	Limestone, Chazy, Black River and Birdseye.	Register No.
1. Stomatopora inflata, Hall		*		5924
2. Berenicea minnesotensis, Ulrich		*		5925
3. Ropalonaria pertenuis, Ulrich		*		5926
4. Arthroclema pulchellum? Billings		*		5927
5. Helopora divaricata, Ulrich		*		5928
6. Helopora spiniformis, Ulrich		*	*?	
7. Helopora, sp. undesc		*		
8. Phyllopora? sp. undet			*	5954
9. Phyllopora? recticulata, Hall		*		5955
10. Phyllopora? corticosa, Ulrich		*		3495
11. Ptilodictya subrecta, Ulrich		*		5929
12. Ptilodictya nodosa, Hall		*		5931
13. Ptilodictya ramosa, Ulrich		*		5930
14. Arthropora shafferi, Meek		*		5932
15. Arthropora simplex, Ulrich		*		5933
16. Stictopora fenestrata? Hall			*	5934
17. Stictopora paupera, Ulrich		*		5935
18. Stictopora fidelis, Ulrich		*		5936
19. Stictopora nicholsoni, Ulrich		*	*?	
20. Stictopora mutabilis, Ulrich		*		5938, 5939, 5966
21. S. mutabilis, var. minor		*		5941
22. S. mutabilis, var. major		*		5940
23. Stictopora, sp. undesc		*		
24. Stictopora, sp. undet		*		
25. Phaenopora multipora, Hall		*		5942
26. Stictoporella angularis, Ulrich		*		5943
27. Stictoporella cribrosa, Ulrich		*		5944
28. Stictoporella frondifera, Ulrich		*		5945–5947
29. Pachydictya foliata, Ulrich		*		5948
30. Pachydictya acuta.? Hall		*		
31. Pachydictya occidentalis, Ulrich		*		5949
32. Pachydictya fimbriata, Ulrich		*		5950
33. Pachydictya conciliatrix, Ulrich		*		5952
34. Pachydictya, sp. undet		*		
35. Phyllodictya frondosa, Ulrich		*		5953
36. Ceramoporella, sp. undesc		*		
37. Ceramoporella? sp undet		*		
38. Crepipora impolita, Ulrich		*		5958–5962
39. Cheiloporella, sp. undesc		*		5963, 5964
40. Spatiopora? areolata, Foord		*		5965, 5966
41. Crepipora? sp undet	*			
42. Monticulipora wetherbyi, Ulrich			*	5967
43. Monticulipora, sp. undesc			*	5968
44. Monticulipora grandis, Ulrich		*		5969
45. Homotrypa minnesotensis, Ulrich		*		5970–5975
46. Homotrypa exilis, Ulrich		*		5976
47. Homotrypa insignis, Ulrich		*		5977–5979
48. Homotrypa subramosa, Ulrich		*		5980
49. Homotrypa, sp undet		*		
50. Homotrypa? sp. undet		*		
51. Homotrypa, sp. undesc	*			
52. Homotrypella instabilis, Ulrich		*		5025, 5981, 5982
53. Atactoporella, sp. undesc		*		5983, 5984
54. Atactoporella, sp. undesc		*		5985
55. Prasopora simulatrix, Ulrich		*		4941, 5124, 5532 5986, 5987, 5988
56. Prasopora conoidea, Ulrich		*		3483
57. Prasopora contigua, Ulrich		*		5301, 5534, 5989
58. Prasopora, sp undesc		*		810, 5990–5992
59. Diplotrypa infida, Ulrich		*		5993
60. Aspidopora parasitica, Ulrich		*		5994, 5995
61. Amplexopora superba, Foord		*		5996–5998
62. Amplexopora winchelli, Ulrich		*		5999–6001
63. Amplexopora, sp. undesc		*		

DISTRIBUTION OF SPECIES—*Concluded.*

	Cincinnati group.	Trenton shales.	Limestone, Chazy, Black River and Birdseye.	Register No.
64. Amplexopora, sp. undet	....	*	....	....
65. Batostoma ottawaensis, Foord	....	*	....	6002
66. Batostoma irrasa, Ulrich	....	*	....	....
67. Batostoma fertilis. Ulrich	....	*	....	....
68. Batostoma, sp. undesc	....	*	....	....
69. Batostoma? sp undet	....	*	....	....
70. Batostoma sp. undet	*	....	....	....
71. Batostomella gracilis, Nicholson	*	....	....	....
72. Batostomella sp. undesc	....	*	....	5541, 6009
73. Trematopora primigenia, Ulrich	....	*	....	6010, 6011
74. Trematopora ornata. Ulrich	....	*	....	....
75. Bythopora herricki Ulrich	....	*	....	6012, 6013
76. Bythopora, sp. undesc	....	*	....	....
77. Bythopora? sp. undesc	....	*	....	....
78. Callopora, sp undesc	....	*	....	6014
79. Callopora, sp undesc	....	*	....	6015
80. Callopora incontroversa, Ulrich	....	*	....	Not entered.
81. Callopora undulata, Ulrich	....	*	....	"
82. Idiotrypa, sp. undesc	....	*	....	"
83. Dekayia trentonensis, Ulrich	....	*	....	"
84. Dekayia, sp. undesc	....	*	....	"
85. Dekayella ulrichi,? Nicholson	....	*	....	"
86. Dekayella, sp. undesc	....	*	....	"
87. Peligopora petechialis, Nicholson	....	*	....	"
88. Peligopora. sp. undet	....	*	....	"
89. Leptotrypa, sp undesc	....	*	....	"
90. Monotrypella multitabulata, Ulrich	....	*	....	"
91. Monotrypella, sp undet	....	....	*	....
92. Monotrypa, sp. undesc	....	*	....	....

REMARKS UPON THE NAMES CHEIROCRINUS AND CALCEOCRINUS, WITH DESCRIPTIONS OF THREE NEW GENERIC TERMS AND ONE NEW SPECIES.

BY E. O. ULRICH.

In 1860, in the thirteenth report of the regents of the N. Y. State University, Prof. James Hall proposed the generic name *Cheirocrinus* for a very anomalous group of palæozoic crinoids. Unfortunately this name had already been proposed in 1856, for a genus of cystideans by Eichwald*, and in 1859 Salter† applied the same name to a species apparently congeneric with the species defined by Hall. The subject is complicated still further by the fact that in 1852 Hall‡ applied the name *Calceocrinus* to some triangular crinoidal plates, now supposed to be the basal piece of a crinoid belonging to the same group as those subsequently referred by the same author to *Cheirocrinus*. So far as I have been able to ascertain, this supposition has not yet been verified, and rests solely upon the resemblance first suggested by Shumard. Admitting the resemblance, I would still protest against the use of *Calceocrinus* instead of *Cheirocrinus*, for the following reasons: (1) According to modern rules of nomenclature, *Calceocrinus* cannot be regarded as an established genus, since it was not founded upon a named nor described species. (2) The triangular plates so designated may belong to any one of at least three distinct generic groups, and as these basal pieces are so nearly alike in all, it is quite impossible to determine from

*Bullet, Soc. Nat. Moscou, p. 69.
†Siluria, 3d edit., p. 535.
‡Pal. N. Y., vol. II, p. 352.

the description and figure, for which of the groups the name would be entitled to stand, in case the first objection is ruled out.

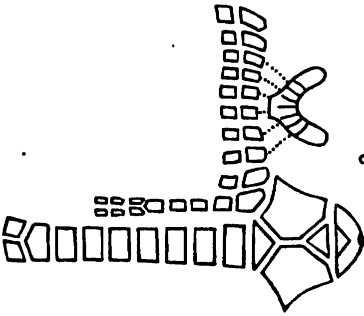
After a careful examination and comparison of the various species of this peculiar family of crinoids now known, I have come to the conclusion that they fall naturally into three distinct and easily distinguished groups. These are separated by such well-marked and constant characters that I feel justified in regarding them as of generic importance. Had I found it possible to determine to which, if any, of these three genera the original specimens of *Calceocrinus* belong, I would have been willing to overlook the objections raised against the use of that name. Being, however, unable to do so, I am obliged to ignore it, when dealing with species whose characters are sufficiently known to make their generic affinities clear, while I would suggest that the name be used temporarily for the reception of such species as are too little known to admit of unquestioned classification, and yet are unequivocal members of the family.

The classification proposed is briefly defined as follows:

CREMACRINIDÆ, n. fam.

Natural position of body and arms drooping. Basal plate subtriangular, composed of several anchylosed pieces, and articulating with the body plates in such a manner as to allow of more or less movement. Columns attached to the lower angle of the basal piece. Plates of body unsymmetrical, consisting on the dorsal side of two large dorso-lateral pieces, and two often much smaller central plates; on the ventral side of three generally completely anchylosed pieces which form an arch adapted to the shape of the movable basal piece. Arms unequal, but developed symmetrically on each side of a centro-dorsal arm, usually much the strongest. Ventral tube long; its supporting plates rest upon the ventral arch.

(Figs. 1, 2 and 3.)



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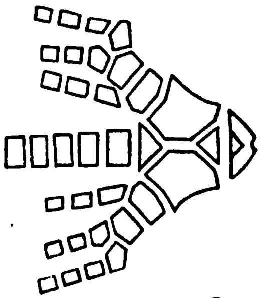

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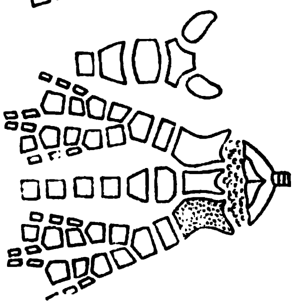

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Fig. 1. Diagram showing structure of body and arms of *Cremacrinus punctatus*, n. gen. *et* sp.
Fig. 2. Diagram showing structure of *Deltacrinus*, n. gen.
Fig. 3. " " " *Halysiocrinus*, n. gen.

CREMACRINUS, n. gen.

Cheirocrinus, Hall, (non Eichwald.)

Base composed of four anchylosed pieces which together form a sub-triangular or semi-elliptical plate, and to the lower angle of which the round column is attached. Body above the base composed of seven plates, four on the dorsal and three on the ventral side. The dorsal plates are separated from the basal piece by a large number of minute plates, seeming to have been imbedded in an articulating ligament. The lower centro-dorsal plate is more or less narrow and separates the two dorso-lateral plates. The upper central plate varies in form from sub-triangular to transversly oblong-subquadrate, and rests upon the lower central, and the upper sloping faces of the dorso-lateral pieces. The latter are much larger than the central plates, higher than wide, subquadrate or sub-rhomboidal in outline, and curved in their upper half around toward the ventral side. The outer margin of each is concave and articulates with one of the sub-ovate lateral pieces of the ventral side. These two pieces incline toward each other, and with the central piece of this side form an arch that corresponds in outline with the lower margin of the basal plate. The central piece is larger than the sub-oval lateral pieces, wider above than below, and four-sided or hexagonal. It supports a series of large but rapidly diminishing plates that form the posterior side of a long and slender ventral tube. The dorsal arm is strong and simple, and rests upon the upper central piece of the body. The first piece of each of the two lateral rays is supported by the upper side of the dorso-lateral plates. The second piece is axillary and supports two equal arms, which are more or less divided above, the divisions being, however, apparently always unequal.

Type: *C. punctatus*, n. sp.

Cremacrinus punctatus, n. sp.

Body small, compressed antero-posteriorly. Basal piece sub-triangular, nearly three times as wide as high, straight along the upper margin, faintly convex on the lower sides, and pointed at the lateral extremities. It is composed of four unequal and

completely anchylosed pieces; the combined outline of the two small upper pieces, which are separated by an impressed central suture, is about parallel with that of the whole piece. The column is small and round, and attached to the slightly truncated lower end. The space between the basal piece and the dorsal plates is filled by numerous small and irregularly distributed plates. The body above the base is comparatively short, about 0.4 inch wide at a point near the middle of the lower half, 0.3 inch at the top, and about 0 2 inch high.

The dorso-lateral plates are sub-quadrate in outline, with all the margins excepting the upper one slightly curved; the upper half is deflected back toward the ventral side. The convex lower centro-dorsal plate extends nearly to the top of the dorso-lateral pieces, is slightly concave on each side, and strongly so below, where the two sides are drawn down into spine-like prolongations; the lower and inner angle of the dorso lateral plates is similarly prolonged, so that the basal line of these plates forms a sigmoid curve. The lower centro-dorsal plate is about 0.1 inch wide below, very slightly narrower above, and about twice as long. The upper centro-dorsal piece is nearly twice as wide as the lower piece, upon which, and the short sloping upper sides of the dorso-lateral plates it rests. It is twice as wide as high, transversely oblong in outline, rather prominent, and apparently, not anchylosed to the other plates of the body. The ventral arch consists of three plates, a sub-triangular central, and one smaller tumid sub-oval plate on each side. Resting on the central piece is the first of a series that supports the long ventral tube. The first and second pieces of this series are large and strongly convex, but the following ones are considerably smaller.

Dorsal arm strong, sub-cylindrical, apparently simple, and composed of pieces that are about as long as wide, and of which six occur in 0.5 inch. The first piece tapers upward and is of the same hight as the succeeding ones. Lateral arms two, one on each side, not as strong as the dorsal ray. The first radial rests upon the upper sloping side of the dorso-lateral plate, and is twice as wide as high. The second is slightly higher, pentagonal, and supports two equal divisions of the ray. Beyond this the arms do not bifurcate, but each second piece throws off

a long slender armlet. These occur alternately on each side of the arm, and give it a slightly zigzag appearance. The arm-pieces are rounded, about as high as wide, and provided with a deep ambulacral furrow within. Entire length of arms at least two inches.

Surface of all the plates covered with rather large and deep punctae, just visible to the unaided eye.

The punctate surface will distinguish this species from the other forms referred to this genus. The centro-dorsal pieces, (especially the lower,) are also large, and the body shorter than in those species. I have seen specimens of a species with similarly punctate plates, from the Trenton limestone at Dixon, Ill. In that species, however, the dorsal arm is much smaller than the lateral ones, while the form of the body and its plates is quite different from those of *C. punctatus*.

The fine specimen from which the above description is drawn, was discovered by Mr. Frank C. Shenahon, and very generously presented by him to the author, in whose cabinet it now is.

Formation and locality: Trenton shales, at Finn's Glen, near Minneapolis, Minn.

DELTACRINUS, n gen.

Basal piece triangular, composed of several anchylosed pieces. Dorsal side of body above the base composed of four more or less firmly united plates. The lower central plate is triangular and entirely separated from the upper triangular piece by the large lateral plates which unite along the central line. Plates of ventral side not determined. Dorsal arm strong, simple or divided. The first piece is the largest and rests upon the upper centro-dorsal plate. The lateral arms are two on each side. The outer one is the strongest, and divides into two equal rays on the second piece. The first plate of the smaller inner arm is cuneate below and rests upon the inner lateral sloping face of the first radial of the outer arm.

Column round, attached to the lower and inner portion of the basal piece.

Type: *Cheirocrinus clarus*, Hall, Hamilton gr.

HALYSIOCRINUS, n. gen.

In the formation of the dorsal side of the calyx, this genus is precisely *Deltacrinus*. The only difference of importance so far detected is found in the number of arms. In *Cremacrinus* we have three primary radials, and in *Deltacrinus* five, while the species for which the above generic term is proposed have eleven,* one large central arm on the dorsal side, and ten smaller ones, the first pieces of which project abruptly outward, and extend in a curved series, transversely around the ventral side. Their inner ends articulate with the ventral arch. All the arms may bifurcate one or more times.

Column round, attached to the slightly truncated lower extremity of the sub-triangular basal piece.

Type: *Cheirocrinus dactylus*, Hall, Burlington limestone.

Aside from *Calceocrinus*, the first notice of American species of this family of crinoids is found in the 13th Regents Report already referred to, in which Hall defines the preoccupied name *Cheirocrinus*, with the following species: *C. chrysalis*, Niagara gr., *C. ventricosus* and *C. dactylus*, Burlington gr., *C. tunicatus* and *C. nodosus* from the Keokuk gr. He also proposed *C. lamellosus*, but until the species for which it is proposed is better described, I am not inclined to recognize the name.† He gives figures of *C. chrysalis*, *C. dactylus* and *C. tunicatus*. In the 15th Regents Report, N. Y., for 1862, he defines and illustrates *C. clarus* from the Hamilton gr., and in 1863, in the Trans. Alb. Inst., vol. iv, *C. stigmatus* is described from the Niagara gr. at Waldron, Ind. Shumard describes *C. perplexus* in 1866, in the Trans. St. Louis Acad. Sci., from strata, supposed to be equivalent to the Keokuk limestone. In 1869, Meek and Worthen describe *C. wachsmuthi* and *C. bradleyi* in the Proc. Acad. Nat. Sci., Phil., the former from the Burlington limestone, the latter from the Keokuk group. Both these species are redescribed and illustrated in vol. v, Geol. Sur., Ill. In 1875, (Geol. Sur., Ill., vol. vi) Worthen describes and figures the body of a Devonian

*So far as the means at hand will admit the determination of this point, all the species referred to the genus, appear to have had eleven arms. The number of lateral and ventral arms might, however, be found to vary in different species.

†Hall's description reads as follows: "Body unknown. Arms with strong lamellose extensions at the joints. Burlington limestone."

species under the name of *Calceocrinus? barrisi*. In 1882, Ringueberg describes and illustrates, (Jour. Cin. Soc. Nat. Hist., vol. v,) *Calceocrinus radiculus* from the Niagara gr. In the 35th Reg. Rep., N. Y., Walcott illustrates and describes *Calceocrinus barrandei* from the Trenton gr. So far as known to me there are only two other species described from American rocks belonging to the *Cremacrinidae*. These are the *Heterocrinus inaequalis* and *H. articulosus* of Billings from the Trenton rocks of Canada, and described and figured by that author in 1859, in the Can. Org. Rem., Decade iv. Of the sixteen species above enumerated, *C. ventricosus*, Hall, *C. perplexus*, Shumard, *C. barrisi*, Worthen and *H. articulosus*, Billings, are too little known to make their reference to any of the three groups proposed certain, and I leave them in the dubious genus *Calceocrinus*, where they have been placed by Mr. S. A. Miller.* The last is most probably founded upon one of the lateral arms of a *Cremacrinus*, while the others may belong either to *Deltacrinus* or *Halysiocrinus*. The twelve species remaining divide up as follows:

C. chrysalis, Hall, *C. inaequalis*, Billings, *C. barrandei*, Walcott, and *C. radiculus*, Ringueberg, agree with *Cremacrinus punctatus*, Ulrich, in having three primary radials, and the dorso-lateral plates entirely separated by the central pieces. In *C. barrandei* and *C. radiculus* the lower centro-dorsal plate is narrow-wedged shaped, and almost pointed above where it articulates with the upper central piece. This plate is wider in *C. punctatus* than it is in any of the other species here referred to *Cremacrinus*, but the separation of the large dorso-lateral plates is nevertheless complete in all. This character and the limited number of primary radials are the distinguishing features of the genus. All the species are Silurian.

The proposed genus *Deltacrinus* will include *C. clarus*, Hall, the type species, *C. stigmatus*, Hall, *C, bradleyi*, M. & W., and very likely *C. tunicatus*, Hall. These species all agree in having the dorso-lateral plates join along the central line of the body. The lower centro-dorsal plate is wide and depressed triangular, the form being quite different from that of the equivalent piece

*Amer. Pal. Foss., p. 72 and 73.

in *Cremacrinus*. The form of the upper central plate resembles the lower in every particular, excepting that the lateral angles are usually obtuse. The arms are known of *C. clarus* and *C. bradleyi* only, but Hall's figures of *Calceocrinus stigmatus* in the 28th Reg. Rep. N. Y., show the articulating scars for the first arm pieces very distinctly and leave little room to doubt that the arms of that species are like those of *C. clarus*. In this species the arms are primarily five, consisting of the large centro-dorsal one, which may be divided once or remain simple throughout, one somewhat smaller lateral arm on each side, and between each of these and the dorsal arm, one still smaller, and differing from the lateral arms, whose second piece is axillary and supports two equal divisions of the ray, in remaining simple throughout, or, at any rate, for a longer distance. These medio-lateral arms are further peculiar because their first piece rests mainly upon the side of the first radial of the lateral arms. Aside from them the arms of *Deltacrinus* do not differ from those of *Cremacrinus*. They furnish, therefore, one of the principal differences between the two genera.

There are at least three American species that have the characters ascribed to *Halysiocrinus*. These are the *C. dactylus* and *C. nodosus*, Hall, and the *C. wachsmuthi*, M. & W., the first and last from the Burlington limestone, and the second from the Keokuk gr. Beside these the *Cheirocrinus gothlandicus* of Angelin, is an unquestionable member of the genus, and Prof. A. H. Worthen will illustrate in the forthcoming vol. viii, of the Ill. Geol. Sur., two specimens from the Keokuk, which resemble the *C. nodosus*, but may prove specifically distinct. In the construction of the body, and in the possession of a strong dorsal arm, these species do not differ from *Deltacrinus*. The lateral arms, however, differ conspicuously from all the species of both *Cremacrinus* and *Deltacrinus*, in being much more numerous, sub-equal and in extending completely around the ventral side. The primary piece of the first of these lateral arms, and a portion of the first piece of the second, rest upon the upper side of the dorso-lateral plate, while the primary pieces of the remaining six ventral arms project abruptly outward, and their inner surfaces or ends articulate with the anchylosed ventral arch. The ventral arms give to these crinoids a very

different appearance from that presented by the more simple species of *Cremacrinus* and *Deltacrinus*. In my opinion they constitute an important deviation from the types of those genera, and fully warrant generic separation. The range of the genus is from the upper Silurian, (*H. gothlandicus*, Ang. sp.,) to the Keokuk group. The Devonian formation is, however, not represented, the other species of the genus known being all from sub-carboniferous deposits.

According to the classification here proposed, the species discussed will be arranged as follows:

CREMACRINIDAE, n. fam.

CREMACRINUS, n. gen.

C. punctatus, Ulrich. Trenton group. (type of genus.)
C. inaequalis, Billings. " "
C. barrandei, Walcott. " "
C. radiculus, Ringueberg Niagara, gr.
C. chrysalis, Hall.

DELTACRINUS, n. gen.

D. clarus, Hall. Hamilton gr. (Type of genus.)
D. stigmatus, Hall. Niagara gr.
D. bradleyi, Meek and Worthen, Keokuk gr.
D.? tunicatus, Hall.

HALYSIOCRINUS, n. gen.

H. dactylus, Hall, Burlington gr. (Type of genus.)
H. wachsmuthi, M. & W. Burlington gr.
H. nodosus, Hall, Keokuk gr.
H. gothlandicus, Angelin, Upper Silurian.

CALCEOCRINUS? Hall.

C. articulosus, Billings, Trenton gr.
C. barrisi, Worthen, Hamilton gr.
C. ventricosus, Hall, Burlington limestone.
C. perplexus, Shumard, Keokuk gr.

IV.

CONCHOLOGICAL NOTES.

BY U. S. GRANT.

A number of shells from various parts of the state have been collected by the geological and natural history survey at different times, but no attempt has been made to obtain a series of specimens illustrating the molluscan fauna of the state. The shells thus obtained were unpacked and classified during the last summer. They are mostly bivalves and are all "dead," thus furnishing only a few good museum specimens, but giving a number of localities. Last summer one week was spent by the writer in collecting in the vicinity of Minneapolis; a few species were added to the collection already obtained, but no thorough search was made; if more time could have been used a much larger number of species probably would have been found. Hennepin county does not seem to be a good locality for land forms and very few were obtained. There are now some eighty species in the University Museum.

The writer wishes to obtain for the survey as many specimens as possible representing different localities. Any shells, even the most common, will be gladly received, and there are quite a number of duplicates to exchange with those who desire. Any of our lakes will furnish several species, and on the muddy banks and sand-bars of the rivers can be found large numbers of fresh-water clams. At low water the sand-bars will in some places be almost covered with dead shells; the live ones will be found in muddy more commonly than in sandy bottoms. As an example of the abundance of fresh-water mollusks in this state, it can be said that thirty species were found in the Minnesota river at Ft. Snelling, and very likely more could have been procured by farther search. It is probable that other rivers of the state can furnish as large a number of species as the Minnesota.

In the following an attempt has been made to give the species so far collected, and the localities, especially those most widely separated. All species and localities can be referred to specimens in the University collection or in that of the writer. It is hoped that more interest may be taken in the shells of the state and that the survey may be aided in acquiring a complete series of the mollusks of Minnesota.

The survey is indebted to the kindness of professor R. Ellsworth Call for the classification of most of the Unionidæ. Descriptions of all of this family could not be easily obtained, and even if the necessary books were handy, the aid of a specialist would be needed in the classification of this family. Prof. Call has also kindly helped in the verification of some of the gasteropoda.

LAMELLIBRANCHIATA.

Family UNIONIDÆ.

Anodonta corpulenta, Cooper—Five or six specimens were obtained in the Minnesota river at Ft. Snelling; only one of them was adult; this approaches *A. grandis* in size, but is much higher in proportion to its length than is *A. grandis*; this specimen is 4 inches high and 5¾ in length. 1496. (These numbers refer to the Zoological Register of the museum.)

Anodonta edentula, Say.—Red river, Wilkin county, and Minnesota river at Granite Falls. This shell is heavier in proportion to its size than any of our other species of this genus. 1441, 1548.

Anodonta ferussaciana, Lea.—Only one specimen has been collected and this was found in the Rum river at Anoka; it measures 1½ inches in length and ⅜ in hight. 1511.

Anodonta grandis, Say.—Rollingstone creek, Minnesota City, and Zumbro river, Wabasha county. This is the largest species of the genus found in Minnesota; it will probably be found quite commonly in some localities. 1589, 1590.

Anodonta imbecilis, Say.—Very abundant in the Minnesota river at Ft. Snelling; a very pretty fragile shell with bright green epidermis, sometimes having faint darker green radiations; the largest specimens found are nearly 2¾ inches long. 1497.

Margaritana complanata, Barnes.—One young shell was found

in the Minnesota river at Ft. Snelling. This species grows to be very large, sometimes measuring over 17 inches in circumference, and not more than 2 inches in width. 1498.

Margaritana confragosa, Say.—This peculiar species has been found only in the Minnesota river at Ft. Snelling; two young specimens were procured and one very fine adult, which is 4¼ inches long and 3½ inches high. This locality is believed to be the most northern from which the shell has been reported, and the first time from Minnesota. 1493.

Margaritana marginata, Say.—Found in the Minnesota river at Granite Falls, and the Mississippi at Ft. Snelling; no full grown specimens are yet in the museum. 1540.

Margaritana rugosa, Barnes—Only one specimen is in the museum; this is about one third grown and was found in the Minnesota river at Granite Falls. The posterior end of this species has a number of peculiar folds that are more distinct near the top of the shell; the nacre is usually of a delicate cream-color. 1541.

Unio æsopus, Green.—Common in the Mississippi river, Dresbach, Winona county. This shell is characterized by a single row of elongated tubercles on each valve extending from the umbone to the lower margin; these tubercles are more in number and not so conspicuous as those on *U. cornutus*. 1480.

Unio alatus, Say.—Red river, Wilkin county; Mississippi river, Winona county; lake Pepin; common in the Minnesota river at Granite Falls and at Ft. Snelling. Three alate species of this genus have been found in the state, *alatus*, *lævissimus*, and *gracilis*; the first two have a red nacre and are of nearly the same size, but the first is a much heavier shell and has stronger teeth; *U. gracilis* is smaller than the others, the epidermis is much lighter in color and is rayed with green, and the red nacre is generally confined to the dorsal portion of the shell. These three species occur quite commonly in the Minnesota river at Ft. Snelling, but more specimens of the last were procured than of the others. 1436, 1472, 1495, 1542.

Unio anodontoides, Lea.—Very abundant in the Minnesota river at Ft. Snelling. A pretty, long, salmon-colored shell; the epidermis has a number of dark rays, but sometimes the rays are nearly obsolete. 1505.

Unio cornutus, Barnes.—Lake Pepin; Mississippi river, Winona county; Minnesota river, Ft. Snelling. This species has not been found very abundantly, but is quite common in Lake Pepin; it is easily recognized by a row of large tubercles on each valve; they extend from the umbone to the lower margin and the largest are raised about a quarter of an inch from the surface of the shell. (See *U. æsopus.*) 1430, 1481, 1506.

Unio ebenus, Lea.—Very abundant in the Mississippi river at Dresbach, Winona county, but has not been found elsewhere. 1484.

Unio elegans, Lea.—Only one specimen is in the museum, and this came from the Minnesota river at Ft. Snelling. A very pretty shell with numerous radiations. 1500.

Unio ellipsis, Lea.—Common in the Mississippi river at Dresbach, Winona county. 1482.

Unio gibbosus, Barnes.—Minnesota river at Ft. Snelling; not common. This species is similar in shape to *U. rectus*, but can be distinguished from it by the coarser undulations on the umbones and by the heavier lateral teeth. The nacre is usually red. 1504.

Unio gracilis, Barnes.—Abundant in the Minnesota river at Ft. Snelling. This shell is oblong and quite fragile and has a light-olive epidermis. The largest specimens obtained are 4½ inches long. (See *U. alatus.*) 1499.

Unio graniferous, Lea.—One dead shell was found in the Mississippi river at Ft. Snelling. 1533.

Unio Lacrymosus, Lea.—Two specimens are in the museum; one from the Red river, Wilkin county, and the other from the Minnesota river, Ft. Snelling. The latter is 2⅝ by 2¼ in. 1435, 1518.

Unio lævissimus, Lea.—Common in the Minnesota river at Ft. Snelling. The shell is very thin and has a shining epidermis. (See *U. alatus.*) 1494.

Unio ligamentinus, Lamarck. Lake Pepin; Mississippi river, Winona county; common in the Minnesota river at Granite Falls. The specimens from Winona county are very heavy: the largest is 5 inches long. 1477, 1545.

Unio luteolus, Lamarck.—Mississippi river, Brainerd; lake Minnewaska, Pope county; White Bear lake; Minnehaha creek,

Hennepin county; Red river, Wilkin county; Mississippi river, Winona county; Rollingstone creek, Minnesota city; lake Minnetonka; Minnesota river, Ft. Snelling; Mississippi river, Anoka county; Rum river, Anoka. This is our most common species and is usually found very abundantly. It is extremely variable. Those found in the lakes in the vicinity of Minneapolis are quite small, fragile, and much eroded, and the radiations are nearly obsolete. The heaviest and largest yet found are from Ft. Snelling; some of these are 5 inches long. The young shells are very beautifully rayed with green. 1423, 1425, 1434, 1443, 1454, 1474, 1485, 1491, 1502, 1509, 1512, 1569.

Unio metanerous, Rafinesque.—Mississippi river, Dresbach, Winona county; Minnesota and Mississippi rivers, Ft. Snelling; rather common in Lake Pepin. This shell has a large ridge extending from the umbones to the basal posterior margin. 1476.

Unio occidens, Lea.—Rather common in the Mississippi river at Dresbach, Winona county. 1478.

Unio parvus, Barnes.—About a dozen specimens were found in the Minnesota river at Fort Snelling; the largest is less than an inch long. This is the smallest species of the genus yet found in the state. 1508.

Unio plicatus, Le Sueur.—Mississippi river, Dresbach, Winona county; Minnesota river at Ft. Snelling and Granite Falls; Lake Pepin. Rather common in these localities. (See *U. undulatus*.) 1473, 1517, 1546.

Unio rectus, Lamarck.—Mississippi river, Brainerd; Red river, Wilkin county; Rum river, Anoka county; Minnesota river, Granite Falls; Mississippi river, Winona county. This species is common and in some places abundant. It is a long straight shell; some of the adults are 5½ in. long and 2½ high. (See *U. gibbosus*.) 1422, 1433, 1503, 1546.

Unio rubiginosus, Lea.—One specimen from the Red river, Wilkin county, is in the museum. 1437.

Unio securis, Lea.—Lake Pepin; Mississippi and Minnesota rivers at Ft. Snelling. Not common, a very pretty straw-colored shell with fine radiations and dark blotches, which are arranged in rows from the umbones to the lower margins. 1516.

Unio solidus, Lea.—One specimen was found in the Mississippi river at Ft. Snelling. 1513.

Unio trigonus, Lea.—Common in lake Pepin and in the Minnesota river at Ft. Snelling. The largest specimens are $2\frac{1}{2}$ inches by 2. 1521.

Unio tuberculatus, Barnes.—Minnesota river at Granite Falls and at Ft. Snelling! Mississippi river, Dresbach, Winona county. This species has not been found to be very common in the localities named. Almost the entire shell, except the posterior portion, is covered with small tubercles. The largest specimen is 5 inches long and $2\frac{5}{8}$ high. 1514, 1543, 1588.

Unio undulatus, Barnes.—Common in the Red river, Wilkin county. This shell resembles *U. plicatus*, but is much thinner; it will probably be found to be rather common. The posterior half of the shell is covered with undulations that run from the umbones obliquely to the lower and posterior margins; these undulations also exist on *U. plicatus*. 1442.

Unio ventricosus, Barnes.—Mississippi river, Brainerd; Red river, Wilkin county; Rum river, Anoka county; Minnesota river at Granite Falls and Ft. Snelling. This is a very common species and widely distributed. The specimens from the Rum river are dark-colored and beautifully rayed with green, while those from the Red river are straw-colored and the radiations are nearly obsolete. 1424, 1439, 1510, 1515, 1544.

Unio zigzag, Lea.—Rather common in the Minnesota river at Ft. Snelling; the largest specimen is 1 inch long and $\frac{11}{16}$ high. This is a very pretty little shell beautifully marked with dark-green. 1501.

CORBICULADÆ.

Sphærium occidentale, Prime.—This species has been found only at Minneapolis, and is not at all common. This family contains quite small bivalves; those found in Minnesota are usually less than half an inch long. 146.

Sphærium partumeium, Say.—Found only at Minneapolis. 1566.

Sphærium rhomboideum, Say.—Only one specimen in the museum; this came from lake Bertram, Wright county. 1565.

Sphærium striatinum, Lamarck.—This species is so far found to be the most common of the genus in this state; it is very common in Minnehaha creek; Minnesota river at Ft. Snelling; and Mississippi and Rum rivers, Anoka county; two specimens

were obtained in lake Bertram, Wright county. This species varies considerably in size, color and thickness; one of the specimens from Wright county is much the largest in the museum; it measures $\frac{5}{8}$ inch in length. 1537, 1538, 1564.

Sphærium transversum, Haldeman.—Common in the Minnesota river at Ft. Snelling. This is the smallest bivalve yet found in the state, being only .15 inch long. 1520.

GASTEROPODA.

HELICIDÆ.

Hyalina arborea, Say—Quite common in the vicinity of Minneapolis; found associated with *Patula striatella*. It is a pretty shining little shell, measuring about $\frac{3}{16}$ of an inch in diameter. 1459.

Helicodiscus lineatus, Say.—Rather common in Hennepin county. This is a small flat shell with one or two small white teeth within the mouth. 1438.

Patula alternata, Say.—Common in Hennepin county; under stones on Nicollet island this shell is very abundant. This is our only large Helix that has reddish-brown blotches on the epidermis; adult specimens are $\frac{3}{4}$ inch in diameter. 1432.

Patula striatella, Anthony.—This is the most abundant land shell in Hennepin county. It is found in almost every damp place under chips and logs; some of the larger specimens are .23 inch in diameter. The surface of the shell is covered with ribs. 1534.

Strobila labyrinthica, Say.—Rather common in Hennepin county. Most of the specimens collected are "dead" shells. 1455.

Stenotrema monodon, Rackett.—Two specimens have been found on the University campus; the largest is .35 inch in diameter. This is a brown shell and quite thick for its size; there is a long narrow white tooth on the inside edge of the mouth. 1461.

Mesodon multilineata, Say.—Found near White Bear lake; common in the vicinity of Minneapolis. This shell is readily distinguished from all others of the family in this state by its size and by the numerous revolving reddish-brown lines. Two specimens were found entirely lacking the revolving lines. This

species can be found crawling about on the ground in damp woods. 1449, 1466.

Vallonia pulchella, Muller.—Found very abundantly under logs on one corner of the University campus, but has not been found elsewhere. This is a small white shell, almost transparent, and the lip is thick and quite broad. The largest specimens are a little more than $\frac{1}{10}$ inch in diameter. 1469.

Cionella subcylindrica, Linnæus.—About twenty specimens have been found near Minneapolis. This is one of our prettiest land shells; the epidermis is shining light-brown, and there is a reddish line on the lip. The shell is .26 inch long and .08 in diameter. 1470.

Succinea obliqua, Say.—Only collected at Minneapolis, where it has so far been found to be rather rare. This species and the next are very pretty delicate shells; sometimes they are found in great numbers on the under sides of the leaves of large weeds. This shell varies from amber-colored to pale, yellowish-green; sometimes the apex has a slight tinge of red, but no specimens in the museum are thus colored. It is the largest shell of this genus found in Minnesota; the largest specimen collected is over three fourths of an inch long. 1467.

Succinea ovalis, Gould.—Found as yet only in Hennepin county, not so rare as the preceding, but still not common. It is much more elongated and delicate than *S. obliqua*, and has a more beautiful amber color. This shell is found on the borders of streams and ponds in damp shady places. The largest shell of this species in the museum is $\frac{6}{10}$ of an inch long. 1468.

AURICULIDÆ.

Carychium exiguum, Say.—The smallest shell yet found in the state; it measures only .07 in. in length and .03 in diameter. This shell has been mistaken many times for a shell belonging to the genus *Pupa*, but the animal is very different. It is found in damp places under logs, chips, etc. It has been collected only on the University campus, where, after more than three hours patient and diligent search, less than a dozen specimens were found. The shell is white and very thin, and there is a small tooth on the body-wall of the aperture. No other species of this family is found far away from the sea coast. 1568.

LIMNÆIDÆ.

Limnæa stagnalis, Linnæus.—Found at Minneapolis; lake Minnewaska, Pope county; White Bear lake; lake Bertram, Wright county; Minnesota river at Granite Falls and Ft. Snelling; and in the vicinity of Rainy river. This is one of the shells that is found in the northern parts of both Europe and America. It is rather fragile for so large a shell; some individuals found at Minneapolis are two inches long. This shell is a common species and, where it occurs, is generally found in large numbers. The animal is nearly black and can be easily pulled out of the shell. 1427, 1431, 1446, 1450, 1507, 1550.

Bulimnea megasoma, Say.—A fine shell and rather heavy, with chestnut-brown within the aperture and sometimes having green stripes on the larger whorls. Two specimens from Knife lake, on the northern state boundary, are in the museum.

Limnophysa reflexa, Say.—Found in the lakes about Minneapolis; also at White Bear lake and Lake City. This shell is very long and slim, sometimes measuring $1\frac{6}{10}$ inches in length and $\frac{9}{20}$ in diameter. 1444, 1455, 1456.

Limnophysa caperata, Say.—Abundant in the vicinity of Minneapolis, but no specimens have been received from other parts of the state. Running around the shell are numerous fine lines which can be seen with the aid of a pocket lens. 1581.

Lymnophysa palustris, Muller.—Found in Lake Minnetonka. This is another form that is common to both Europe and America. It is very variable and has a large synomony. The shells found in lake Minnetonka correspond to *L. elodes*, Say.

Physa gyrina, Say.—Minneapolis; Rum river, Anoka; Mississippi river at Anoka and Ft. Snelling. Very common and in some places abundant.—Specimens vary from dark-brown to light-brown. 1452, 1576, 1577, 1578.

Physa heterostropha, Say.—Cedar lake, Minneapolis; Minnehaha creek; Mississippi river at Anoka and Ft. Snelling. This is much prettier and more abundant than the preceding species. The specimens collected are rather small. 1457, 1463, 1522, 1539.

Bulinus hypnorum, Linnæus.—Common in one pond near Minneapolis, but has not been found elsewhere. This is a fragile, shining, dark-brown shell. The animal is black. This species

is found in Europe and America. The largest specimens are $\frac{3}{4}$ inch long and $\frac{6}{20}$ inch in diameter. 1465.

Planorbella campanulata, Say.—Lake Minnetonka; White Bear lake; Minneapolis; Wright county. A very common shell, abundant in some places. Some specimens from Wright county are nearly $\frac{3}{4}$ of an inch in diameter. 1429, 1447, 1462, 1464, 1489, 1552, 1574, 1592.

Helisoma bicarinatus, Say.—Minneapolis; lake Minnewaska, Pope county; Wright county. Common but not so much so as the preceding species. One specimen is over $\frac{3}{4}$ of an inch in diameter; but this shell does not usually grow to be so large. 1428, 1453, 1553, 1591.

Helisoma trivolvis, Say.—Minnesota river at Granite Falls and Ft. Snelling; Minneapolis; White Bear lake; along the northern boundary. Very common. The specimens found in one pond near Minneapolis are extremely black; large shells from Ramsey county are over an inch in diameter. This species varies greatly in size. 1448, 1451, 1549, 1554, 1570, 1571, 1572, 1573.

Gyraulus deflectus, Say.—Very common in the lakes about Minneapolis; also found in lake Bertram, Wright county. This is a small flat species with the aperture bent down below the centre of the shell—whence the name. The largest specimens are $\frac{5}{16}$ inch in diameter, and about $\frac{1}{12}$ inch high. 1575, 1582.

VALVATIDÆ.

Valvata tricarinata, Say.—Very common in the lakes of Wright and Hennepin counties. This shell is easily distinguished by its three raised revolving lines, one on the upper edge of the whorl, one on the lower, one on the base. The largest specimen in the museum is from Buffalo lake, Wright county, and is nearly a quarter of an inch in diameter. This species and the preceding are found clinging to the plants in the shallow water of our lakes. 1460, 1555, 1593.

VIVIPARIDÆ.

Vivipara intertexta, Say.—This shell seems to be very common in White Bear lake, but has not been found elsewhere. It is the only species of this genus found as yet in Minnesota. 1445.

Melantho decisa, Say.—Binney gives both *M. subsolida*, Auth. and *rufa*, Hald. as synonyms of this species; the latter has been

found common in the Rum river, Anoka county, the former is common in the Minnesota river at Ft. Snelling, and abundant in the Mississippi river at Minneapolis. The largest specimens are about 1½ inches high and ⅞ in diameter.

Lioplax subcarinata, Say.—Rather common in the Minnesota river at Ft. Snelling and found associated with the preceding species. No large individuals were found. The specimens vary from sharply carinated ones to those with no appreciable carinæ. 1486.

RISSOIDÆ.

Bythinella obtusa, Lea.—Common in the Minnesota river at Ft. Snelling, but not found elsewhere. This and the three following species are found in the mud on the banks of rivers; they can be collected by getting a sieve full of the mud and then washing it out with water; sometimes quite a quantity of shells will be left in the sieve. This species is about .14 inch long. 1535.

Somatogyrus subglobosus, Say.—Abundant in the Minnesota river at Ft. Snelling. No specimens from any other locality are in the museum. The shell is rather thin and when cleaned is of a light horn-color, sometimes with a reddish tinge on the apex. The largest specimens are .22 inch high and .19 in diameter. 1471.

Amnicola cincinnatensis, Anthony.—Common in the Minnesota river at Ft. Snelling and the Rum river, Anoka County. This species is thicker and larger than the following. One specimen from the Rum River is a quarter of an inch long. 1584, 1585.

Amnicola porata, Say.—Common in the Minnesota river at Ft. Snelling, and in the lakes near Minneapolis. This shell is quite thin and nearly transparent. 1586, 1587.

STREPOMATIDÆ.

Pleurocera subulare, Lea.—This is the only species of this family yet found by the survey in Minnesota. It is very common in the Minnesota river at Ft Snelling, and in the Mississippi and Rum rivers, Anoka county. Specimens from the Minnesota river are smaller than the others and the shell is not so thick; those found in the Rum river are very large, old, and much eroded; several are over ⅞ inch long. 1531, 1532, 1583.

V.

REPORT ON THE MUSEUM FOR 1885.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1885.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens	Locality.	Formation.	Collector and Remarks
5773	May, 1885.	Exchange......	Platystoma peoriense, McCh...............	2	Peoria Co , Ill...........	....	From W. H. Adams.
5774	"	"	Spirifera lineata. Morton................	10	" "	....	" "
5775	"	"	Spirifera camerata, Morton........	1	Knox Co., Ill............	....	" "
5776	"	"	Spiriferina kentuckiensis. Sh............	4	Peoria Co. Ill	....	" "
5777	"	"	Rhynchonella illinoiensis, Worth........	5	" "	....	" "
5778	"	"	Rhynchonella metallica, White	2	" "	....	" "
5779	"	"	Rhynchonella uta, Marcou...	6	Peoria and Knox Co's Ill.	....	" "
5780	"	"	Chonetes mesoloba, N & P.............	5	" " "	....	" "
5781	"	"	Chonetes parva, Sh.......................	15	" " "	....	" "
5782	"	"	Pleurotomaria grayvillensis, N. & P......	3	" " "	....	" "
5783	"	"	Pleurotomaria subturbinata, Meek & H....	1	Peoria Co., Ill...........	....	" "
5784	"	"	Athyris subtilita, Hall....................	9	" "	....	" "
5785	"	"	Athyris royissii..........................	2	" "	....	" "
5786	"	"	Retzia mormoni, Marcou	8	" "	....	" "
5787	"	"	Lophophyllum proliferum, McCh..........	21	Peoria and Knox Co's Ill.	....	" "
5788	"	"	Cyathaxonia distorta, Worth	3	Peoria Co., Ill	....	" "
5791	"	"	Productus muricatus, N. & P.............	10	Knox Co., Ill	....	" "
5792	"	"	Pleurotomaria illinoiensis	1	" "	....	" "
5793	"	"	Productus nebrascensis, Owen............	1	" "	....	" "
5794	"	"	Productus prattenianus, Norwood	5	" "	....	" "
5795	"	"	Nucula ventricosa, Hall..................	2	" "	....	" "
5796	"	"	Bellerophon carbonarius, Cox.............	4	Peoria and Knox Co's Ill	....	" "
5797	"	"	Bellerophon montfortanus, N. & P	4	Knox Co., Ill...........	....	" "
5798	"	"	Terebratula bovidens, Morton	2	" "	....	" "
5799	"	"	Petrodus occidentalis, N. & W	1	Peoria and Knox Co's Ill.	....	" "
5800	"	"	Discina nitida, Phillips..................	1	Knox Co., Ill.....	....	" "
5801	"	"	Nautilus decoratus, Cox	1	" "	....	" "
5802	"	"	Trachydomia nodulosa, Worth	7	Peoria Co., Ill	....	" "
5803	"	"	Streptorhynchus crassus, M. & H..	4	Peoria and Knox Co's, Ill.	....	" "
5804	"	"	Phillipsia scitula, M. & W......	1	Peoria Co., Ill..........	....	" "
5805	"	"	Fusulina cylindrica, Fiss.................	9	Peoria and Knox Co's, Ill.	....	" "

5806	"	"	Macrocheilus primigenius, Conr	2	Peoria Co., Ill		"	"	
5808	"	"	Trigonocarpus adamsi, Lesq	16	West Jersey, Stark Co, Ill.		"	"	
5809	"	"	Carpolithes perpusillus	5	" " "		"	"	
5810	"	"	Trigonocarpus starkianus, Lesq	6	" " "		"	"	
5811	"	"	Rhabdocarpus mammillatus, Lesq	6	" " "		"	"	
5812	"	"	Trigonocarpus noeggerathi, Brgt	1	" " "		"	"	
5813	"	"	Trigonocarpus dawsi, L. & H	1	" " "		"	"	
5863	"	Geol Survey	White clay	1	Red Wing, Minn.		N. H. Winchell.		
5864	March, 1885.	Presented	Tufaceous deposit	1	Yellowstone Nat. Park		From Prof. H. S. Baker, St. Paul.		
5866	June, 1885.	"	Oriskany sandstone	1	Schoharie, N. Y		"	Chas. E. Hall.	
5867	"	"	Magnetite and Apatite	1	Mineville, Essex Co., N.Y.		"	"	"21 Bed" Mine.
5868	"	"	Specular iron ore	1	Rossie, St. L. Co., N. Y.		"	"	Caledonia Mine.
5869	"	"	Red slate	1	Middle Granville, Wash. Co., N Y		"	"	Primordial slate.
5870	"	"	Utica slate (with graptolites)	2	Holland Patent, N. Y		"	"	
5872	"	"	Oriskany sandstone	1	Oriskany Falls, N. Y		"	"	
5873	"	"	Coralline limestone	1	Schoharie, N. Y		"	"	
5874	"	"	Variegated slate	1	Middle Granville, Wash. Co., N Y		"	"	Primordial slate.
5875	"	"	Plumbago	1	Ticonderoga, Essex Co., N. Y		"	"	Old lead mine.
5876	"	"	Clinton ferruginous sandstone	1	Ilion, N. Y		"	"	
5877	"	"	Magnetite and Mica	1	Crown Point, Essex Co., N. Y	Lower Lau	"	"	
5878	"	"	Birdseye limestone (with fucoid)	1	Canajoharie, N. Y		"	"	
5880	"	"	Gray sandstone	1	Ilion, N. Y		"	"	
5881	"	"	Water lime	1	Manlius N. Y		"	"	
5882	"	"	Chazy limestone	2	Isle La Motte, N. Y		"	"	
5883	"	"	Labradorite	1	Little Falls, N. Y		"	"	
5885	"	"	Calciferous sandstone	2	" "		"	"	
5886	"	"	Gneiss	1	Rossie, St. Law. Co., N.Y.		"	"	Rocks associated with galena.
5887	"	"	Labradorite	1	Little Falls, N. Y		"	"	
5889	"	"	Tentaculite limestone	1	Schoharie, N. Y		"	"	
5890	"	"	Vein rock	1	Rossie, St. Law. Co., N.Y.		"	"	" "
5891	"	"	Sandstone	1	Potsdam, N. Y	Potsdam	"	"	
5892	"	"	Schoharie grit	1	Schoharie, N. Y		"	"	
5893	"	"	Calciferous sandstone	2	Little Falls, N. Y		"	"	Showing bituminous matter, quartz & calcite.
5894	"	"	Labradorite	1	" "		"	"	
5895	"	"	Labradorite	1	" "		"	"	
5896	"	"	Breccia	1	Rossie, St. Law. Co., N.Y.		"	"	Caledonia mine.
5897	"	"	Primordial limestone	1	Swanton Vt		"	"	
5898	"	"	Goniatite limestone	1	Schoharie, N. Y		"	"	
5899	"	"	Purple slate	1	Middle Granville, N. Y		"	"	
5900	"	"	Gray garnetiferous gneiss	1	Saratoga Co., N. Y		"	"	

Specimens registered in the General Museum in 1885.—*Continued.*

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5901	June, 1885	Presented	Gneiss	1	Crown Point, Essex Co., N. Y.		From Chas. E. Hall.
5902	"	"	Magnetite	1	Mineville, Essex Co., N. Y.		" " New bed mine.
5903	"	"	Calciferous sandstone	1	Little Falls, N. Y.		" "
5904	"	"	Labradorite	1	" "		" "
5906	"	"	Cauda Galli grit	1	Clarksville, Albany Co., N. Y.		" "
5907	"	"	Marble	1	Gouverneur, N. Y.		" "
5908	"	"	Magnetite	6	Mineville, Essex Co., N. Y.		" " New bed mine.
5909	"	"	Rock associated with ore	8	Gilboa, N. Y.		" "
5911	"	"	Quartz crystals	25	Little Falls, N. Y.		" "
5912	"	"	Sample of building stone	1	Potsdam, N. Y.	Potsdam	" " Cube of sandstone, 1 ft. sq.
5913	"	Geol. Survey	Sample of building stone (1 ft x 1ft. x6 in.)	1	Mankato, Minn	St. Law	N. H. Winchell from Fowler & Ring.
5914	"	"	" " " "	1	" "	"	N. H. Winchell from W. B Craig & Co.
5915	"	"	" " " "	1	" "	"	" "
5916	"	"	" " " "	1	" "	"	" "
5917	"	"	Sample of building stone (pink)	1	Kasota, Minn	Shak.	" from C. W. Babcock's quarries.
5918	"	"	Sample of building stone (white)	1	" "	"	" "
5919	July, 1884	"	Hematite	Ind.	Tower City, Vermillion lake, Minn.		" Breitung mine.
5920	"	"	Hematite	"	" " "		" Stone "
5921	"	"	Hematite	"	" " "		" Breitung "
5922	"	"	Repressed brick	6	Dresbach, Minn		" from Sherwood & Johnson.
5923	1884	Presented	Red quartzyte (striated)	1	Pipestone City, Minn		C. H. Bennett.
5924	1877	Geol. Survey	Stomatopora inflata, Hall	1	Minneapolis, Minn	Trenton	N. H. Winchell. From 5537.
5925	1885	"	Berenicea minnesotensis, Ulrich	1	" "	"	E. O. Ulrich.

5926	1876–1879	"	Ropalonaria pertenuis, Ulrich	1	" "	Trenton shales.	C. L. Herrick. Attached to Pachydictya foliata, Ul.
5927	1880	"	Arthroclema pulchellum, Bill	1	St. Paul, Minn	Trenton	N. H. Winchell.
5928	1885	"	Helopora divaricata, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
5929	"	"	Ptilodictya subrecta, Ulrich	1	" "	"	"
5930	"	"	Ptilodictya ramosa, Ulrich	1	" "	"	"
5931	"	"	Ptilodictya nodosa, Hall	1	" "	"	"
5932	"	"	Arthropora shaffen, Meek	1	" "	"	"
5933	"	"	Arthropora simplex, Ulrich	1	" "	"	"
5934	"	"	Stictopora fenestrata (?) Hall	1	" "	"	"
5935	"	"	Stictopora paupera, Ulrich	1	" "	"	"
5936	"	"	Stictopora fidelis, Ulrich	1	" "	"	"
5937	Sept. 1880.	"	Stictopora fidelis, Ulrich	1	Near Lanesboro, Minn	"	N. H. Winchell. From 4080.
5938	1885	"	Stictopora mutabilis, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
5939	Aug. 1877.	"	Stictopora mutabilis	1	St. Paul, Minn	"	N. H. Winchell. From 2562.
5940	1885	"	Stictopora mutabilis, var. major	1	Minneapolis, Minn	"	E. O. Ulrich.
5941	"	"	Stictopora mutabilis, var. minor	1	" "	"	"
5942	1876–1879	"	Phaenopora multipora	1	" "	"	C. L. Herrick. From 5125.
5943	1885	"	Stictoporella angularis, Ulrich	1	" "	"	E. O. Ulrich.
5944	"	"	Stictoporella cribrosa, Ulrich	1	" "	"	"
5945	1882	"	Stictoporella frondifera, Ulrich	1	Sec. 6, Fremont, Winona Co., Minn	"	Presented by W. H. Shelton. From 4671.
5946	1876–1879	"	Stictoporella frondifera	1	Minneapolis, Minn	"	C. L. Herrick From 5125.
5947	1885	"	Stictoporella frondifera	1	" "	"	E. O. Ulrich.
5948	"	"	Pachydictya foliata, Ulrich	1	" "	"	"
5949	1880	"	Pachydictya occidentalis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. From 5538.
5950	1885	"	Pachydictya fimbriata, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
5951	Aug., 1877.	"	Pachydictya fimbriata (?)	1	St. Paul, Minn	"	N. H. Winchell.
5952	Aug., 1883.	Presented	Pachydictya conciliatrix, Ulrich	1	Cannon River Falls, Goodhue Co., Minn	Trenton	Presented by W. H. Scofield. From 5308.
5953	1885	Geol. Survey	Phyllodictya frondosa, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
5956	1880	"	Stictopora mutabilis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. From 5338.
5957	"	"	Stictopora mutabilis	1	" "	"	" very old. From 5338.
5958	1885	"	Crepipora impolita, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
5959	1878	"	Crepipora impolita	1	Minneapolis, Minn, (Finn's Glen)	"	N. H. Winchell. From 380.
5960	Aug., 1877.	"	Crepipora impolita, Ulrich	1	Minneapolis, Minn	"	C. L. Herrick. From 797.
5961	Sept., 1880.	"	Crepipora impolita	1	Near Lanesboro, Minn	"	N. H. Winchell. From 4086.
5962	1876-1879	"	Crepipora impolita	1	Minneapolis, Minn	"	C. L. Herrick. From 5128.
5967	1885	"	Monticulipora wetherbyi, Ulrich	1	" "	Chazy (?)	E. O. Ulrich.
5968	"	"	Monticulipora incompta, Ulrich	1	" "	Trenton shales.	"
5969	"	"	Monticulipora grandis, Ulrich	1	" "	"	"
5970	"	"	Homotrypa minnesotensis, Ulrich	1	" "	"	"
5971	1882	"	Homotrypa minnesotensis	1	" "	"	N. H. Winchell. From 4937.
5972	Sept., 1880	"	Homotrypa minnesotensis	1	Near Lanesboro, Minn	"	" " 4036.
5973	"	"	Homotrypa minnesotensis	1	Near Fountain, Minn	"	" " 4050.

Specimens registered in the General Museum in 1885.—*Continued.*

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens	Locality.	Formation.	Collector and Remarks.
5974	1882	Geol. Survey.	Homotrypa minnesotensis	1	Minneola, Goodhue Co., Minn	Trenton shales.	N. H. Winchell. From 4996.
5975	1876-1879	"	Homotrypa minnesotensis	1	Minneapolis, Minn	"	C L. Herrick. " 5128.
5976	1885	"	Homotrypa exilis, Ulrich	1	" "	"	E. O. Ulrich.
5977	Aug., 1877.	"	Homotrypa insignis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. Type. From 2578.
5978	1885	"	Homotrypa insignis (?)	1	Minneapolis, Minn	"	E. O. Ulrich.
5979	1880	"	Homotrypa insignis (?)	1	Near Fountain, Minn	"	N. H. Winchell. From 3589.
5980	1882	"	Homotrypa subramosa, Ulrich	1	Minneola, Goodhue Co., Minn.	"	" " 4996.
5981	Oct., 1875.	"	Homotrypella instabilis, Ulrich	1	Fillmore, Fillmore Co., Minn	"	" " 259.
5982	1876-1879	"	Homotrypella instabilis	1	Minneapolis, Minn	"	C. L. Herrick. " 5128.
5983	Aug., 1877.	"	Atactoporella occidentalis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. " 2562.
5984	"	"	Atactoporella occidentalis	1	Minneapolis, Minn	"	" " 2578.
5985	"	"	Atactoporella insueta, Ulrich	1	" "	"	C. L. Herrick. " 754.
5986	1872	"	Prasopora simulatrix, Ulrich	1	Pettit's Mill, Mantorville, Minn	Trenton (?)	N. H. Winchell. From 842.
5987	1882	"	Prasopora simulatrix	1	Sec. 16, Minneola, Goodhue Co., Minn	Trenton shales.	" " 4997.
5988	1877	"	Prasopora simulatrix	1	St. Paul, Minn	"	"
5989	1882	"	Prasopora contigua, Ulrich	1	Sec. 16, Minneola, Goodhue Co., Minn	"	" " 4997.
5990	Sept., 1880.	"	Prasopora insularis, Ulrich	1	Near Fountain, Minn	"	" " 4064.
5991	1882	"	Prasopora insularis	1	Sec 16, Minneola, Goodhue Co., Minn	"	" With (at a) Petigopora asperula, Ulrich. From 4997
5992	1872	"	Prasopora insularis	1	Pettit's Mill, Mantorville, Minn	Trenton (?)	" From 342.
5993	Sept., 1880.	"	Diplotrypa infida, Ulrich	1	Near Fountain, Minn	Trenton shales.	" " 4064.
5994	....	"	Aspidopora parasitica, Ulrich	1	Lanesboro, Minn	"	"
5995	1885	"	Aspidopora parasitica	1	Minneapolis, Minn	"	E. O. Ulrich.
5996	"	"	Amplexopora superba, Foord	1	" "	"	"
5997	1876-1879	"	Amplexopora superba	1	" "	"	C. L. Herrick. From 2128.
5998	Aug., 1877.	"	Amplexopora superba	1	St. Paul, Minn	"	N. H. Winchell. " 2578.
5999	"	"	Amplexopora winchelli, Ulrich	1	" "	"	" " 2578.

6000	1876-1879	"	Amplexopora winchelli	1	Minneapolis, Minn	"	C. L. Herrick. " 5128.
6001	1885	"	Amplexopora winchelli (?)	1	" "	"	E. O. Ulrich
6002	Oct., 1872.	"	Batostoma ottawaensis, Foord	1	Pettit's Mill, Mantorville, Minn	Trenton	N. H. Winchell " 357.
6003	1885	"	Batostoma irrasa, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
6004	1882	"	Batostoma irrasa (?)	1	Minneola, Goodhue Co., Minn	"	N. H. Winchell. " 4996.
6005	"	"	Batostoma irrasa (?)	1	Minneola, Goodhue Co., Minn	"	" " 4996.
6006	1875	"	Batostoma fertilis, Ulrich	1	Minneapolis, Minn	"	" " 282.
6007	Nov., 1884.	Presented	Batostoma fertilis	1	Eyota, Minn	"	Presented by Miss Carrie S. Seymour. From 5581.
6008	1876-1880	Geol Survey.	Batostoma fertilis	1	Minneapolis, Minn	"	C. L. Herrick. From 5128.
6009	1879	"	Batostamella ramulosa, Ulrich	1	Oxford Mills, near Cannon Falls, Minn	"	N. H. Winchell. " 3486.
6010	1880	"	Trematopora primigenia, Ulrich	1	Near Fountain, Minn	"	" " 5529.
6011	1885	"	Trematopora primigenia	1	Minneapolis, Minn	"	E. O. Ulrich.
6012	1876-1879	"	Bythopora herricki, Ulrich	1	" "	"	C. L. Herrick. " 5121
6013	....	"	Bythopora herricki	1	St. Paul, Minn	"	....
6014	....	Dr. Stoneman.	Callopora prematura, Ulrich	1	....	"	Records doubtful. From 79.
6015	....	Geol.Survey.	Callopora fraudulenta, Ulrich	1	Near Fountain, Minn	"	....
6016	Sept., 1880.	"	Dekayia trentonensis, Ulrich	1	" "	"	N. H. Winchell. From 4050.
6017	1885	"	Dekayia trentonensis	1	Minneapolis, Minn	"	E. O. Ulrich.
6018	Sept., 1880.	"	Dekayia internexa, Ulrich	1	Near Lanesboro, Minn	"	N. H. Winchell. " 4030
6019	1876-1879	"	Dekayella contracta, Ulrich	1	Minneapolis, Minn	"	C. L. Herrick. " 5128.
6020	Sept., 1880.	"	Dekayella contracta	1	Near Lanesboro, Minn	"	N. H. Winchell. " 4036.
6021	1885	"	Dekayella contracta	1	Minneapolis, Minn	"	E. O. Ulrich.
6022	1878	"	Monotrypella multitabulata, Ulrich	1	Minneapolis Minn.(Finns Glen)	"	N. H. Winchell. " 330.
6023	Oct., 1875.	"	Monotrypella multitabulata	1	Fillmore, Fill. Co., Minn.	"	" " 259.
6024	1885	"	Leptotrypa indiffens, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
6025	"	Presented	Sporangites huronensis (?)	2	East Cleveland, O	Bedford shales.	From Rev. O. Hertzer.
6026	Aug., 1885.	Geol.Survey.	Ferruginous quartz schist	1	Black River Falls, Wis.	....	N. H Winchell. Dubuque mine. No. 2.
6027	"	"	" " "	1	" "	....	N. H. Winchell. York's opening. Mound No. 2, near the river.
6028	"	"	" " "	1	" "	....	N. H. Winchell. From the pit of Big Mound.
6029	"	"	" " "	1	" "	....	N. H. Winchell. Average surface specimen of the Big Mound.
6030	"	"	" " "	1	" "	....	N. H. Winchell. Summit of the Big Mound.
6031	"	"	" " "	1	" "	....	N. H. Winchell. Mound No. 5.
6032	"	"	" " "	1	" "	....	" Dubuque mine.
6033	"	"	Red quartzyte	1	" "	....	"
6034	"	"	Hematite	1	" "	....	" Drift No. 1.
6035	"	"	Potsdam shale	1	" "	....	" At the "Blue specular" drift.

Specimens registered in the General Museum in 1885.—*Continued.*

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens	Locality.	Formation.	Collector and Remarks.
5974	1882	Geol. Survey...	Homotrypa minnesotensis	1	Minneola, Goodhue Co., Minn	Trenton shales.	N. H. Winchell. From 4996.
5975	1876-1879	"	Homotrypa minnesotensis	1	Minneapolis, Minn	"	C L. Herrick. " 5128.
5976	1885	"	Homotrypa exilis, Ulrich	1	" "	"	E. O. Ulrich.
5977	Aug., 1877.	"	Homotrypa insignis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. Type. From 2578.
5978	1885	"	Homotrypa insignis (?)	1	Minneapolis, Minn	"	E. O. Ulrich.
5979	1880	"	Homotrypa insignis (?)	1	Near Fountain, Minn	"	N. H. Winchell. From 3539.
5980	1882	"	Homotrypa subramosa, Ulrich	1	Minneola, Goodhue Co., Minn.	"	" " 4996.
5981	Oct., 1875.	"	Homotrypella instabilis, Ulrich	1	Fillmore, Fillmore Co., Minn.	"	" " 259.
5982	1876-1879	"	Homotrypella instabilis	1	Minneapolis, Minn	"	C. L. Herrick. " 5128.
5983	Aug., 1877.	"	Atactoporella occidentalis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. " 2562.
5984	"	"	Atactoporella occidentalis	1	Minneapolis, Minn	"	" " 2578.
5985	"	"	Atactoporella insueta, Ulrich	1	" "	"	C. L. Herrick. " 754.
5986	1872	"	Prasopora simulatrix, Ulrich	1	Pettit's Mill, Mantorville, Minn	Trenton (?)	N. H. Winchell. From 342.
5987	1882	"	Prasopora simulatrix	1	Sec. 16, Minneola, Goodhue Co., Minn	Trenton shales.	" " 4997.
5988	1877	"	Prasopora simulatrix	1	St. Paul, Minn	"	"
5989	1882	"	Prasopora contigua, Ulrich	1	Sec. 16, Minneola, Goodhue Co., Minn.	"	" " 4997.
5990	Sept., 1880.	"	Prasopora insularis, Ulrich	1	Near Fountain, Minn	"	" " 4064.
5991	1882	"	Prasopora insularis	1	Sec 16, Minneola, Goodhue Co., Minn	"	" With (at a) Petigopora asperula, Ulrich. From 4997
5992	1872	"	Prasopora insularis	1	Pettit's Mill, Mantorville, Minn	Trenton (?)	" From 342.
5993	Sept., 1880.	"	Diplotrypa infida, Ulrich	1	Near Fountain, Minn	Trenton shales.	" " 4064.
5994	....	"	Aspidopora parasitica, Ulrich	1	Lanesboro, Minn	"	"
5995	1885	"	Aspidopora parasitica	1	Minneapolis, Minn	"	E. O. Ulrich.
5996	"	"	Amplexopora superba, Foord	1	" "	"	"
5997	1876-1879	"	Amplexopora superba	1	" "	"	C. L. Herrick. From 2128.
5998	Aug., 1877.	"	Amplexopora superba	1	St. Paul, Minn	"	N. H. Winchell. " 2578.
5999	"	"	Amplexopora winchelli, Ulrich	1	" "	"	" " 2578.

6000	1876-1879	"	Amplexopora winchelli	1	Minneapolis, Minn	"	C. L. Herrick. " 5123.
6001	1885	"	Amplexopora winchelli (?)	1	" "	"	E. O. Ulrich
6002	Oct., 1872.	"	Batostoma ottawaensis, Foord	1	Pettit's Mill, Mantorville, Minn	Trenton	N. H. Winchell " 857.
6003	1885	"	Batostoma irrasa, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
6004	1882	"	Batostoma irrasa (?)	1	Minneola, Goodhue Co., Minn	"	N. H. Winchell. " 4996.
6005	"	"	Batostoma irrasa (?)	1	Minneola, Goodhue Co., Minn	"	" " 4996.
6006	1875	"	Batostoma fertilis, Ulrich	1	Minneapolis, Minn	"	" " 282.
6007	Nov., 1884.	Presented	Batostoma fertilis	1	Eyota, Minn	"	Presented by Miss Carrie S. Seymour. From 5581.
6008	1876-1889	Geol Survey	Batostoma fertilis	1	Minneapolis, Minn	"	C. L. Herrick. From 5123.
6009	1879	"	Batostamella ramulosa, Ulrich	1	Oxford Mills, near Cannon Falls, Minn	"	N. H. Winchell. " 3486.
6010	1880	"	Trematopora primigenia, Ulrich	1	Near Fountain, Minn	"	" " 5529.
6011	1885	"	Trematopora primigenia	1	Minneapolis, Minn	"	E. O. Ulrich.
6012	1876-1879	"	Bythopora herricki, Ulrich	1	" "	"	C. L. Herrick. " 5121.
6013		"	Bythopora herricki	1	St. Paul, Minn	"	
6014		Dr. Stoneman	Callopora prematura, Ulrich	1		"	Records doubtful. From 79.
6015		Geol.Survey	Callopora fraudulenta, Ulrich	1	Near Fountain, Minn	"	
6016	Sept., 1880.	"	Dekayia trentonensis, Ulrich	1	" "	"	N. H. Winchell. From 4050.
6017	1885	"	Dekayia trentonensis	1	Minneapolis, Minn	"	E. O. Ulrich.
6018	Sept., 1880.	"	Dekayia internexa, Ulrich	1	Near Lanesboro, Minn	"	N. H. Winchell. " 4030
6019	1876-1879	"	Dekayella contracta, Ulrich	1	Minneapolis, Minn	"	C. L. Herrick. " 5128.
6020	Sept., 1880.	"	Dekayella contracta	1	Near Lanesboro, Minn	"	N. H. Winchell. " 4036.
6021	1885	"	Dekayella contracta	1	Minneapolis, Minn	"	E. O. Ulrich.
6022	1878	"	Monotrypella multitabulata, Ulrich	1	Minneapolis Minn. (Finns Glen)	"	N. H. Winchell. " 380.
6023	Oct., 1875.	"	Monotrypella multitabulata	1	Fillmore, Fill. Co., Minn.	"	" " 259.
6024	1885	"	Leptotrypa indiffens, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
6025	"	Presented	Sporangites huronensis (?)	2	East Cleveland, O	Bedford shales.	From Rev. O. Hertzer.
6026	Aug., 1885.	Geol.Survey	Ferruginous quartz schist	1	Black River Falls, Wis.		N. H Winchell. Dubuque mine. No. 2.
6027	"	"	" " "	1	" "		N. H. Winchell. York's opening, Mound No. 2, near the river.
6028	"	"	" " "	1	" "		N. H. Winchell. From the pit of Big Mound.
6029	"	"	" " "	1	" "		N. H. Winchell. Average surface specimen of the Big Mound.
6030	"	"	" " "	1	" "		N. H. Winchell. Summit of the Big Mound.
6031	"	"	" " "	1	" "		N. H. Winchell. Mound No. 5.
6032	"	"	" " "	1	" "		" Dubuque mine.
6033	"	"	Red quartzyte	1	" "		"
6034	"	"	Hematite	1	" "		" Drift No. 1.
6035	"	"	Potsdam shale	1	" "		" At the "Blue specular" drift.

Specimens registered in the General Museum in 1885.—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
6036	Aug., 1885.	Geol.Survey...	Magnesian schist	1	Black River Falls, Wis.	....	N. H. Winchell.
6037	"	"	Grand Rapids plaster	1	Grand Rapids, Mich.	....	"
6038	Aug. 15,1885	Presented......	Chloritic red granite	Ind.	Sleepy Eye, Minn	....	Presented by C. M. Hunt. From a well 260 feet deep, (8 feet in this rock.
6039	Sept., 1885.	"	Refined rock salt	"	Marine City, Mich	....	From Marine City Stone Co.
6040	"	"	Calcareous tufa	1	S. Moccasin Mts., Mont.	....	" Rudolf Von Tabel, Jr.
6041	"	"	Orthis remnicha, Winch	1	Red Wing, Minn	....	From Dr. J. H Sandberg. In the street, 2 feet below the surface, in front of his office. Mostly the same level as No. 6042
6043	"	"	Feldspar (after leucite)	2	Magnet Cove, Ark	....	From J. F. Kunz.
6047	"	"	Schist	1	Near Falkenstein, Saxony	....	" C. L. Herrick.
6048	"	"	Slate	1	Near Altorf, north of St Gothard	....	" "
6071	"	Geol.Survey...	"Deposited silica"	1	Belvidere, Goodhue Co., Minn	Madison......	N. H. Winchell.
6072	Aug. 5, 1885	"	Drift sand .... Orig. No. 1.	Indef	Minneapolis, Minn		" 18 feet.
6073	"	"	Lime rock .... Orig. No. 2.	"	" "	Drillings from the deep well at the West hotel.	" 10 "
6074	"	"	Green shales .... Orig. No. 3.	"	" "		" 10 "
6075	"	"	White sandrock .... Orig. No. 4.	"	" "		" 91 "
6076	"	"	Yellow sandrock .... Orig. No. 5.	"	" "		" 30 "
6077	"	"	Yellow sandrock .... Orig. No. 6 and 7.	"	" "		" 5 "
6078	"	"	White sandrock .... Orig. No. 8.	"	" "		" First flow of water, (Red shale 4 feet.) 10 feet.
6079	"	"	Yellow sandrock .... Orig. No. 9.	"	" "		" 18 feet.
6080	"	"	Gray sandrock .... Orig. No. 10.	"	" "		" 6 "
6081	"	" ...	Red quartzyte .... Orig. No. 11.	"	" "		" effervesces feebly. 32 feet.
6082	"	"	Siliceous fine limestone ...... Orig. No. 12.	"	" "		" 40 feet.
6083	"	"	Red siliceous limestone ...... Orig. No. 13.	"	" "		" 10 "

6084	"	"	Limestone with white sand ..Orig. No. 14.	"	" "	Drillings from the deep well at the West hotel.	" Similar to No. 12, but rather yellowish-pink. 15 feet.
6085	"	"	Calcareous quartzyte..........Orig. No. 15.	"	" "		" 6 feet.
6086	"	"	Fine, light pinkish limestone..Orig. No. 16.	"	" "		" 30 "
6087	"	"	White sand ....Orig. No. 17.	"	" "		" Second flow of water. 5 feet.
6088	"	"	Fine pinkish sand, very hard.Orig. No. 18.	"	" "		" 1 foot.
6089	"	"	Rounded, coarse, white sand..Orig. No. 19.	"	" "		" Water increased to No. 20. 90 feet.
6090	"	"	Calcareous shale..............Orig. No. 20.	"	" "		N. H. Winchell. 45 feet.
6091	"	"	Green shale.......................Orig. No. 21.	"	" "		" 104 "
6092	"	"	Hard sub-crystalline shale....Orig. No. 22.	"	" "		" 12 "
6093	"	"	White sandrock...............Orig. No. 23.	"	" "		" Third flow of water. 30 feet.
6094	Oct., 1883.	By Exchange..	Bryozoa	"	Keokuk, Iowa	Keokuk	From A. S. Tiffany, Davenport, Ia
6095	"	"	Sperifera strigosus, Meek..................	3	Rockford, Iowa...........	Chemung	" "
6096	"	"	Sperifera whitneyi, Hall....................	2	" "	"	" "
6097	"	"	Sperifera hungerfordi, Hall................	2	" "	"	" "
6098	"	"	Sperifera	1	Buffalo, Iowa.............	Hamilton.......	" "
6099	"	"	Orthis cyclus, Hall.............................	2	Rock Island Ill..........	"	" "
6100	"	"	Orthis iowensis, Hall	3	" "	"	" "
6101	"	"	Orthis suborbicularis, Hall	1	" "	"	" "
6102	"	"	Orthis	2	Rock Island and Scott Co., Ia..............	"	" "
6103	"	"	Athyris spiriferoides, Eaton	8	18 mile creek, Erie Co., N. Y..................		" "
6104	"	"	Athyris vittata, Hall..........................	4	Buffalo, Iowa.............	Hamilton.......	" "
6105	"	"	Atrypa reticularis, Linn	4	Rockford, Iowa...........	Chemung	" "
6106	"	"	Monticulipora	2	Buffalo, Iowa..	Hamilton	" "
6107	"	"	Productus longispinus, Law	1	Atkinson, Ill.....	Coal Meas......	" "
6108	"	"	Productella dissimilis, Hall................	6	Rockford, Iowa...........	Chemung	" "
6109	"	"	Strophonella reversa, Hall..................	5	" "	"	" "
6110	"	"	Pentamarella urata, Con....................	1	Buffalo, Iowa......... ...	Hamilton	" "
6111	"	"	Strophodonta demissa, Con................	2	Davenport, Iowa.........	"	" "
6112	Sept., 1885.	Geol.Survey....	Drillings. Rock, about 2 feet thick, black,	Indef	Browns Valley.............	....	From J O. Barrett, at 360 feet.
6113	"	"	" Stratum of green colored.......	"	" "	....	" " 450 "
6114	"	"	" Quick-sand	"	" "	....	" " 460 "
6115	"	"	" Rock below 75 feet..................	"	Mankato, Minn...........	....	" A. F. Beckdolt. Well on Third St Depth of well 96 feet.
6116	"	Presented......	" Gray syenitic rock	"	Herman, Minn............	....	From Chas. Pullman. At 150 ft.
6117	"	"	" Gray syenitic rock	"	" "	....	" " 152 "
6118	Oct., 1885.	Geol.Survey. ..	Marly Clay	"	Albert Lea, Minn........	....	" E. D. Edward. From 12-18 in. below the surface.
6119	"	"	Drift fragment, "Northern limestone".....	1	Washington Co., Minn...	Drift	N. H. Winchell
6120	"	"	Oglshkie Muncie conglomerate	1	Marine Mills, Minn.......	"	"
6121	Nov., 1885.	"	Hematite..	1	Black River Falls, Minn.	....	"

Specimens registered in the General Museum in 1885.—*Continued.*

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks
6122	Nov., 1885.	Geol Survey	Catlinite	2	Barron Co., Wis.		N. H. Winchell.
6123	Oct., 1885.	Presented	Cryptozoon proliferum	1	8 miles west of Saratoga Springs, N. Y.	Calciferous	From. C E. Hall. With a thin section of the same.
6124	"	"	Dioryte	2	Near Palisade, Dak.		From J. E. Todd.
6125	"	Geol. Survey	Drillings. Granite below 280 feet	Ind.	Milbank, Grant Co., Dak.		From J. W. Williams. 1st, 75 ft. blue clay; 2d, 200 ft. shale; 3d, 8 ft. gravel & shells; 4th, the granite.
6126	"	Presented	Hyolithellus micans, Billings	1	Columbia Co., N. Y.	L Potsdam	From S. W. Ford.
6127	"	"	" " and Fordilla troyensis, Barr	1	Columbia Co., N. Y., near Schodack Landing	"	" "
6128	"	"	Stenotheca rugosa, Hall	1	" " "	"	" "
6129	"	"	Microdiscus speciosus, Ford	1	Troy, N. Y.	"	" " Head and pygidia.
6130	"	"	" " and lobatus, Hall	1	Columbia Co., N. Y.	"	" " With embryo of Olenellus asaphoides.
6131	"	"	Graptolithus sagittarius, pristis and gracilis	5	Schodack Landing, N. Y. Rensselaer Co.	Lorraine shales	From S. W. Ford.
6132	"	"	" " bicornis and scalaris	3	" " "	"	" "
6133	"	"	" scalaris and bicornis	1	" " "	"	" "
6134	"	"	" furcatus and pristis	2	" " "	"	" "
6135	"	"	" pristis	1	" " "	"	" "
6136	"	"	Archimedes wortheni ?	6	Russelville, Ky.	Carbon.	From G. R. Lumsden, Greenville, Conn.
6137	"	"	Pentremites godonii, DeFrance	5	" "	"	" " "
6138	"	"	Pentamerus galeatus	5	" "	Up. Silurian	" " "
6139	"	"	Petraia corniculum	1	" "	Low. Silurian	" " "
6140	"	"	Chenopus pes-pelicana, Phill	1	Asti in Piedmont	Pliocene	" " "
6141	"	"	Trochus majus, Lamark	1	" "	"	" " "

6142	"	"	Cancellaria cancellata, Lam.	1	" "	"	"	"	"
6143	"	"	Buccinium prismaticum, (Brug.)	1	Castell arquanto, Parma.	Mushcelsand	"	"	"
6144	"	"	Pectunculus polydonta, Bronn	1	Flonheim, Rheinhessen	Miocene	"	"	"
6145	"	"	Corbula revoluta, Lam.	2	Bordeaux	"	"	"	"
6146	"	"	Astarte omalii	2	Antwerpen	"	"	"	"
6147	"	"	Cyrena subarata, Brown	2	Alzey, Rheinhessen	"	"	"	"
6148	"	"	Cerythium margaritaceum, Broig	1	" "	"	"	"	"
6149	"	"	" cinctum, Lam	2	" "	"	"	"	"
6150	"	"	" inconstans, B	5	Wien	"	"	"	"
6151	"	"	Fusus burdifakensii, Lam	1	Bordeaux	"	"	"	"
6152	"	"	Cyclostoma bisulcatum, Zeit	1	Hochheim, Mainz	"	"	"	"
6153	"	"	Lamna cuspidata, Agassiz	3	Flonheim, Rheinhessen	"	"	"	"
6154	"	"	Nummulites dufrenoy, d'Arch	10	Adelholzen		"	"	"
6155	"	"	Leda deshajesana, (d'Orb.)	1	Basele, Antwerpen	Eocene	"	"	"
6156	"	"	Cerithium cristatum, Lam	2	Rheims	"	"	"	"
6157	"	"	Turritella imbricata, Ley	2	Conizae		"	"	"
6158	"	"	Fusus bulbiformis, Det	1	Barton Cliff, Hampshire	Eocene	"	"	"
6159	"	"	Rostellaria	2	Paris	"	"	"	"
6160	"	"	Inoceramus sulcatus, Lam	3	Perte du Rhone		"	"	"
6161	"	"	Scyphia fuscata	1			"	"	"
6162	"	"	Terebratula sella, Sow	2	Sheppenstedtin, Braunsweig		"	"	"
6163	"	"	Cyrena heysii, D	1	Obernkirchen, Westphalen	Weald. Clas.	"	"	"
6164	"	"	Paludina fluviorum, Mantell	1	Osterwald	"	"	"	"
6165	"	"	Pentacrinus pentagonia, Gold	3	Streitberg, Bayern	Coral Crag	"	"	"
6166	"	"	Millericrinus horridus, d'Orb	1	Launoy, Dept. des Ardennes		"	"	"
6167	"	"	Ammonites hecticus	1	Gammelshausen, Wurtt.	Oxford Clay	"	"	"
6168	"	"	Terebratula perovalis, Sow	1	Aalen, Wurtenberg		"	"	"
6169	"	"	Terebratula numismalis, Sow	1	Rautenberg, Braunschweig	Mid. Lias	"	"	"
6170	"	"	Ammonites amaltheus, Sehl	2	Plateau de Larzae, France	Up. Lias	"	"	"
6171	"	"	Ammonites oxynodus, Am	1	Goeppingen, Wurtenberg.	L. Lias.	"	"	"
6172	"	"	Cidaris dorsata, Bronn	3	St. Cassian, Tyrol	Triassic	"	"	"
6173	"	"	Nucula frigillata, Golaf	1	" "	"	"	"	"
6174	"	"	Naticella cortata	1	" "	"	"	"	"
6175	"	"	Pleurotomaria radiata, Wi	5	" "	"	"	"	"
6176	"	"	Terebratula vulgaris, (Sehl)	2	Bayreuth		"	"	"
6177	"	"	Avicula socialis, Deshays	1	Erkerode, Braunschweig	Mid. Trias	"	"	"
6178	"	"	Trigonia vulgaris, (Sehl)	1	Bayreuth		"	"	"
6179	"	"	Avicula spelinaria	1	Altenstein, Thuringen	Mgn. limestone.	"	"	"
6180	"	"	Orthis mickclini, Ver.	1	Vise, Belgien	Mt. limestone	"	"	"
6181	"	"	Spirifer lineatus, Buch	3	" "	Carb. limestone	"	"	"
6182	"	"	Cyathophyllum caespetosum, Goldf	1	Refrath, Bensberg	Dev. limestone.	"	"	"
6183	"	"	Terebratula primpelaris, Buch	1	Gerolstein, Eifel	"	"	"	"
6184	"	"	Atrypa reticularis, (d'Orb)	1	Renfrath, Coeln		"	"	"

Specimens registered in the General Museum in 1885.—Concluded.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
6185	Oct., 1885.	Presented......	Orthis eipliensis..........................	1	Gerolstein, Eifel.........	Dev. limestone.	From G. R. Lumsden, Greenville, Conn.
6186	"	"	Orthis resupinata, F. Roemer..............	1	" "	"	" " "
6187	"	"	Murchisonia bilineata (d'Arch)...........	2	Paffrath, Coeln..........	"	" " "
6188	"	"	Goniatites retrorsus, Buch................	2	Budesheim, Eifel...	Dev. shales....	" " "
6189	"	"	Terebratula linguata, Buch.........	2	Carlshutte, Beraun......	....	" " "
6190	"	"	Orthis elegantala, (Dalm)..................	1	Klinteham, Gottland....	....	" " "

ARCHÆOLOGICAL SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1885.

131. Stone implement found in digging the foundation of Hanover College, Jefferson county, Ind., on the Ohio river bluff. By purchase at the New Orleans industrial and cotton centennial exposition, from—Powers, 1885.

132. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

133. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

134. Stone implement from southern Indiana, near the Ohio river bluff. By purchase from Powers, 1885.

135. Stone implement from Austin, Scott county, Ind. By purchase from Powers, 1885.

136. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

137. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

138. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

139. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

140. Stone implement from Chickamauga creek, near the battle ground, Tenn. By purchase from Powers, 1885.

141. Stone pestle from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

142. Stone pestle from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

143. Stone pestle from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

144. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

145. Four stone axes from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

146. Two stone disks dug from a mound in Charleston, Mo. Found with a skeleton. By purchase from Powers, 1885.

147. Chert implement dug from a mound at Charleston, Mo. By purchase from Powers, 1885.

148. Chert spear-head from Charleston, Mo. By purchase from Powers in 1885.

149. Stone disk from top of Lookout mountain, Ala. By purchase from Powers, 1885.

150. Stone disk from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

151. Stone implements (three) from Doty's mill on Big creek, Jennings tp., Scott county, Ind. By purchase from Powers, 1885.

152. Chert spear-head. Near Lexington, Scott county, Ind. By purchase from Powers, 1885.

153. Large chert hoe. Mississippi river, Ballard county, Ky. By purchase from Powers, 1885.

154. Fourteen chert implements out of a nest of 23 pieces, all standing edgewise, plowed up on the farm of Hon. Wm. H. English, Lexington, Scott county, Ind. By purchase from Powers, 1885.

155. Three scrapers from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

156. Three chert scrapers from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

157. Two chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

158. Fifteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

159. Fourteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

160. Fifteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

161. Ten chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

162. Eight chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

163. Eight rough chert implements from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

164. Twelve chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

165. Two chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

166. One chert knife from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

167. One chert knife from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

168. Five chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

169. Chert implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

170. Eight chert chisels from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

171. Eight chert drills from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

172. Fourteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

173. Eleven chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

174. Eight chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

175. Four chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

176. Nine chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

177. Eleven chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

178. Two chert implements from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

179. Eight chert implements from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

180. Catlinite goblet. Pipestone City, Minn. By purchase, 1885.

181. Catlinite goblet. Pipestone City, Minn. By purchase, 1885.

182. Catlinite paper-weight. Pipestone City, Minn. By purchase, 1885.

183. Catlinite pipe, with spear-head bowl and wooden stem. Pipestone City, Minn. By purchase, 1885.

184. Catlinite pipe, with "dog's-head bowl" and wooden stem. Pipestone City, Minn. By purchase, 1885.

185. Catlinite pipe, with "horse-head" bowl and wooden stem. Pipestone City, Minn. By purchase, 1885.

186. Catlinite pipe, with tomahawk bowl and stone stem. Pipestone City, Minn. By purchase, 1885.

187. Catlinite pipe, with hand holding the bowl and wooden stem. Pipestone City, Minn. By purchase, 1885.

188. Catlinite pipe, with tomahawk head. Pipestone City, Minn. By purchase, 1885.

189. Catlinite pipe. Pipestone City, Minn. By purchase, 1885.

190. Catlinite pipe, with tomahawk bowl and stone handle, (all one piece.) Pipestone City, Minn. By purchase, 1885.

191. Old pipe, plowed up at St. Paul, Minn.

192. Fragments (three) of Indian pottery. From mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

193. Fragments (seven) of skulls from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

194. Implements of bone from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

195. Implements of bone from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

196. One knife, highly finished, of granular quartzyte, 9 inches long by 2½, from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

197. Stone implement from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

198. Unfinished stone pipe from mounds at the mouth of

Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

Besides the foregoing, the collections of Dr. H. E. Twitchell have been deposited in the museum, to remain at least four years. These will finally be presented to the museum by Dr. Twitchell, according to his present design. They comprise several hundred specimens, characteristic of the mound-builders of Indiana and Ohio.

ZOOLOGICAL

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
918	....	Geomys bursarius, (Shaw) Rich.	...	Hennepin Co., Minn.	M't'd
919	....	Sula bassania, (Linn.) Bris.	....	Florida	"
920	....	Nest and egg of Hummer	....	California	....
921	....	Nest of Hummer	....	"	....
922	....	Nest of Flycatcher	....	"	....
923	....	Nest of Titmouse	....	"	....
924	....	Loligo pealii, LeS. (Dissection)	....	Salem, Mass.	Alcohol..
926	....	Salmo namaycush, Block	....	Grand Marais	"
927	....	Stizostelhium vitreum	....	"	"
928	....	Vertebra of a whale	....	Salem Harbor, Mass.	Dry
929	....	Acipenser rubicundus LeS	F.	Minneapolis	M't'd
931	....	Ovis montana, Cuv. Head.	M.	Near Ft. Benton, Mon.	Dry
932	....	Rangifer caribou, Aud. & Bach. Head.	....	Near Grand Marais.	"
933	....	Process of vertebra of whale	....	Bakers Isl'd, Salem, Mass	"
934	....	Lingula anatina	....	Higo, Japan	Alcohol..
935	....	Pityophis melanoleucus, Holb.	....	Ramsey Co., Minn	"
936	....	Sceloporus undulatus, Harlan	....	Sherwood, Tennessee	"
937	....	Eutænia	F.	Minneapolis.	"
938	....	Amblystoma punctatum (L.) Baird	....	"	"
939	....	" "	...	"	"
940	....	Ostrea borealis, 1 day old	....	Rowes Oyster Farm, L.I.S	Dried
941	....	" " 2 weeks old	....	" " "	"
942	....	" " 2 years old	....	Ludington's beds, New Haven, Conn.	"
943	....	" " 2 years, 4 months old	....	H. C. Rowes Farm, L.I.S.	"
944	....	" " 3 years old	....	" " "	"
945	....	" " 4 " "	....	" " "	"
946	....	" " 5 " "	....	Ludington's beds, New Haven, Conn	"
947	....	" " 7 " "	....	" " "	"
948	....	" " 17 " "	....	Natural bed Indian Neck, Conn	"
949	....	" " 25 " "	....	" " "	"
950	....	Lepas Hillia	....	Turks Island	Alcohol..
951	....	Pyrula carica (Winkle Shell)	....	Long Island Sound	Dry
952	....	Pyrula canaliculata (Spawn of Winkle)	....	New Haven, Conn.	"
953	....	Crepidula	....	" "	"
954	....	Gorgonia	....	Hampton, Va., Johns Hopkins, Biol. Lab.	Alcohol..
955	....	Balanoglossus	....	" " "	"
956	....	"	....	" " "	"
957	....	Amphioxus lanceolatus	....	" " "	Corr. Sublimate.
958	....	" "	....	" " "	Alcohol..
959	....	" "	....	" " "	Picric Acid.
960	....	" "	....	" " "	Chromic Acid...
961	3	Fiber zibethicus, (L.) Cuv.	....	Minneapolis	M't'd
962	18	Geomys bursarius, (Shaw) Rich.	M.	"	"
963	19	" "	F.	"	"
964	27	Condylura cristata, (L.) Desm.	....	Hinckley, Minn.	"
965	28	Putorius ermineus, Cuv	....	" "	"
966	36a	Sciuropterus volucella	....	Monticello, Minn	"
967	36b	" "	....	" "	"
968	9	Tamias striatus, (L.) Baird	....	Hinckley, Minn.	"
969	8	Sciurus hudsonius, Pallas	....	Pine City, Minn.	"
970	6	" carolinensis, Auct.	....	Minneapolis	"
971	33	Tamias striatus, (L.) Baird	....	Hinckley, Minn.	"
972	....	Picoides arcticus, (Swains) Gray	M.	"	"
973	....	" "	M.	"	"

REGISTER.

Collected by	When collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
E. Lyman Hood ...	May 28, 1881.	May, 1881.	E. Lyman Hood ...	1	Presented.
....	....	"	Regent Chute	1	"
E. L. Huggins	....	March, 1881	E. L. Huggins.....	1	"
"	....	"	"	1	"
....	....	"	"	1	"
	....	"	"	1	"
C. W. Hall.........	1880	1880	C. W. Hall.........	1	....
"	August, 1881.	1881	"	2	....
"	"	"	"	1	....
"	August, 1880.	"	"	......	....
M. Pettingill.......	July, 1880.	"	M. Pettingill.......	......	Presented.
S F. Peckham.....	1880	"	C. W. Hall.........	1	Depos'td by C.W.H
Mayhew Bros......	"	"	Mayhew Bros......	1	....
C W. Hall..........	"	"	C. W. Hall.	2	....
Prof. E. S. Morse ..	1879	1880	Prof. E. S Morse..	1	Presented.
Thos. S Roberts...	1882	1882	Thos. S. Roberts...	1	"
N. H. Winchell....	1881	1881	N. H. Winchell....	1	"
N. M. Baker.......	1882	1882	N. M. Baker.......	1	" Dissected to show viscera.
R. M. Bell.........	"	"	R. M. Bell.........	1	Presented. Dissected to show nervous system.
"	"	"	"	1	Presented. Dissected to show viscera
H. C. Hovey.......	1883	1883	H. C. Hovey	Indef.	Presented after the Minneapolis meeting, A. A. A. S.
"	"	"	"	"	
"	"	"	"	3	
"	"	"	"	7	
"	"	"	"	5	
"	"	"	"	1	
"	"	"	"	1	
"	"	"	"	2	
"	"	"	"	1	
"	"	"	"	1	
Geo. W. Mansfield.	1882	1882	Geo. W. Mansfield.	Indef.	Presented.
H. C. Hovey......	1883	1883	H. C. Hovey	2	"
"	"	"	"	2	"
"	"	"	"	1	"
H. F. Nachtrieb...	"	"	H. F. Nachtrieb...	1	"
" ...	"	"	"	Indef.	"
" ...	"	"	"	"	"
" ...	"	"	"	Sev'rl	"
" ...	"	"	"	"	"
" ...	"	"	"	"	"
" ...	"	"	"	"	"
C. L. Herrick......	October, 1883.	Oct., 1883.	Geol. & N. H. Sur.	1	....
"	Nov., 1883.	Nov., 1883.	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	Dec., 1883.	Dec., 1883.	" "	......	....
"	"	"	" "	......	....
"	Nov., 1883.	Nov., 1883.	" "	......	....
"	"	"	" "	......	....
"	Oct., 1883.	Oct., 1883.	" "	......	....
"	Nov., 1883.	Nov., 1883.	" "	......	....
"	"	"	" "	1	....
"	"	"	" "	1	....

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen
974	....	Picoides arcticus	F.	Hinckley, Minn	M't'd
975	....	" "	F.	"	"
976	....	Hesperiphona vespertina, (Cooper) Baird	M.	Minneapolis	"
977	....	" "	F.	"	"
978	41	Lynx rufus, (Gold) Raf	M.		
979	34	" "	F.	Hinckley, Minn	M't'd
980	43	" " Young	....	"	
981	....	Lanius ludovicianus excubitorides, (Sw) Coues	F.		M't'd
982	305	Carpodacus purpureus, (Gm.) Bd	M.	Minneapolis	"
983	404	Xanthocephalus icterocephalus, (Bp.) Bd	F		"
984	117	Ceryle alcyon, (L.) Boie	F.	Minneapolis	"
985	232	Ampelis garrulus, Linn	....	Richfield, Minn	"
986	122	Geothlypsis trichas, (L.) Caban	M.	Minneapolis	"
987	261	Harporhynchus rufus, (L.) Caban	F.	"	"
988	434	Cyanocitta cristata, (L.) Strickl	....		"
989	326	Centrophanes lapponicus	F.	Sandy Lake	"
990	414	Icterus spurius (L.) Bp	M.		"
991	76	Picus pubescens, Linn	F.	Minneapolis	"
992	349	Zonotrichia albicollis, (Gm.) Bp	M.	"	"
993	158	Sialia sialis, (L.) Haldem	M.	"	"
994	217	Setophaga ruticilla, (L) Sw	M.	Bet. Minneapolis & St. P.	"
995	391	Pipilo erythropthalmus, (L.) Vieill	M.	Sandy Lake, Hennepin Co	"
996	112	Caprimulgus vociferus, Wils	M.	Minneapolis	"
997	213	Myiodioctes pusillus, (Wils.) Bp	M.	"	"
998	319	Loxia leucoptera Gm	M.	"	"
999	302	Eremophila alpestris, (Frost) Boie	F.	Sandy Lake, Anoka Co	"
1000	302	" " Young	F.	" " "	"
1001	302	" " "	M.	" " "	"
1002	559	Fulica americana, Gmel	....	Medicine Lake, Henn. Co	"
1003	194	Dendrœca coronata, (L.) Gray	M.	Minneapolis	"
1004	61	Nyctea scandiaca, (L.) Newt	M.	Windom, Cottonwood Co	"
1005	48	Bubo virginianus, (Gm.) Bp	M.	Near Osseo, Hennepin Co	"
1006	233	Ampelis cedrorum (Vieill) Bd	....	Minneapolis	"
1007	254	Galeoscoptes carolinensis, (L.) Caban	M.	"	"
1008	504	Oxyechus vociferus, (L.) Reich	M.	Sandy Lake, Anoka Co	"
1009	400	Molothrus ater, (Bodd) Gray	M.	" " "	"
1010	400	" "	F.	" " "	"
1011	317	Chrysomitris pinus, (Wils.) Bp	F.		"
1012	400	Molothrus ater, (Bodd.) Gray	....	Minneapolis	"
1013	39	Aquila chrysætus canadensis. (L.) Ridgw	M.	Winnipeg, Manitoba	"
1014	39	" " "	F.	" "	"
1015	39	" " "	M.	" "	"
1016	39	" " "	F.	St. Croix River	"
1017	43	Haliætus leucocephalus, (L.) Savig	M.	Howard Lake, Wright Co	"
1018	43	" "	F.	Monticello	"
1019	43	" " Young	....	Manitoba	"
1020	44	Pandion haliætus carolinensis (Gm.) Ridgw	....		"
1021	14	Astur atricapillus, Linn	M.	Near Medicine Lake, Hennepin Co	"
1022	14	" "	F.	Medicine Lake, Henn. Co	"
1023	14	" "	F.	On Watertown Road	"
1024	14	" "	M.	Moore Lake, Anoka Co	"
1025	38	Circus hudsonius, (L.) Vieill	M.	Bet. Minneapolis & St. P.	"
1026	38	" " " " Young	M.	Near Medicine Lake, Hennepin Co	"
1027	38	" "	F.	St. Paul	"
1028	....	Aesalon columbarius (L.) Kaup	....		"
1029	13	Tinnunculus sparverius, (L.) Vieill	F.	Near Sandy, Anoka Co	"
1030	....	" "	....		"
1031	28	Buteo borealis, (Gm.) Vieill	M.	Minneapolis	"
1032	....	" "	....		"
1033	48	Bubo virginianus, (Gm.) Bp	M.	Bet. Minneapolis & St. P.	"
1034	48	" "	F.	Rockford, Wright Co	"
1035	61	Nyctea scandiaca, (L.) Newt., Young	M.	Windom, Cottonwood Co	"

Register.—Continued.

Collected by	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
C. L. Herrick......	Nov., 1883.	Nov., 1883.	Geol. & N. H. Sur.	1	....
"	"	"	" "	1	....
"	Jan., 1883 (?)	Jan., 1883(?)	" "	1	....
"	Oct., 1883.	Oct., 1883.	" "	1	....
N. H. Winchell....	Nov., 1883.	Nov., 1883.	" "	1	....
C. L. Herrick......	"	"	" "	1	....
"	Feb., 1883.	Feb., 1883.	" "	1	....
Wm. Howling	....	1884	Wm. Howling	1	By purchase.
"	1879	"	"	4	"
"	....	"	"	1	"
"	July 20, 1880.	"	"	1	"
"	Dec. 12, 1881.	"	"	4	"
"	July 1, 1879.	"	"	1	"
"	1879	"	"	1	"
"	....	"	"	1	"
"	June, 1879.	"	"	1	"
"	....	"	"	2	"
"	1880	"	"	1	"
"	June 1, 1882.	"	"	1	"
"	July 27, 1881.	"	"	1	"
"	June 26, 1882.	"	"	1	"
"	1880	"	"	2	"
"	July 17, 1880.	"	"	1	"
"	June 13, 1880.	"	"	1	"
"	1880	"	"	2	"
"	July 21, 1881.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	June 18, 1882.	"	"	1	"
"	May 18, 1881.	"	"	1	"
"	Dec. 20, 1880.	"	"	1	"
"	1884	"	"	1	"
"	....	"	"	1	"
"	1882	"	"	1	"
"	June 20, 1879.	"	"	1	"
"	July 31, 1883.	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	April 9, 1883.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	1875	"	"	1	"
"	June 5, 1883.	"	"	1	"
"	April 21, 1884.	"	"	1	"
"	April 9, 1883.	"	"	1	"
"	....	"	"	1	"
"	1883	"	"	1	"
"	1881	"	"	1	"
"	1883	"	"	1	"
"	May 30, 1882.	"	"	1	"
"	October, 1883.	"	"	1	"
"	August, 1882.	"	"	1	"
"	1879	"	"	1	"
....	....	....	....	1	....
Wm. Howling.....	May, 1879.	1884	Wm. Howling.....	1	By purchase.
....	....	....	....	1	....
Wm. Howling.....	June 30, 1875.	1884	Wm. Howling.....	1	By purchase.
....	....	....	....	1	....
Wm. Howling	1883	1884	Wm. Howling.....	1	By purchase.
"	1882	"	"	1	"
"	June 31, 1881.	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1036	61	Nyctea scandiaca	F.	Moose lake, Anoka Co	M't'd
1037	54	Strix debulosa, Forst	M.		"
1038	51	Asio americanus, (Steph) Sharpe	M.	Nr. Silver L, Ramsey Co.	"
1039	52	Asio accipitrinus, (Pall.) Newt	M.	Bet. Minneapolis & St P.	"
1040	52	" "	F.	Near Sandy L, Anoka Co	"
1041	52	" "	M.		"
1042	....	Haliaetus leucocephalus, (L) Savig	....		"
1043	....	" "	....		"
1044	....	Buteo borealis, (Gm.) Vieill	....		"
1045	....	Astur atricapillus, (Wils) Bp			"
1046	14	" " young.	M.	Anoka, Anoka Co	"
1047	27	Buteo pennsylvanicus (Wils.) Bp	M.	Wright Co.	"
1048	1	Cathartes aura (L.) Illig	M.	Lake Minnetonka	"
1049	49	Scops asio, (L.) Bp	M.	Coon Creek, Anoka Co	"
1050	49	" "	F.	Nr. L. Calhoun, Anoka Co	"
1051	47	Aluco flammeus americanus, (Aud.) Ridgw	M.	....	"
1052	112	Caprimulgus vociferus, Wils	F.	Near Sandy L, Anoka Co.	"
1053	112	" " "	M.	" " "	"
1054	114	Chordeiles popetue, (Vieill) Bd	M.	Minneapolis	"
1055	114	" "	F.	"	"
1056	94	Melanerpes erythrocephalus, (L.) Sw.	M.	"	"
1057	97	Colaptes auratus, (L.) Sw	F.	"	"
1058	90	Hylotomus pileatus, (L.) Bd	M.	Wright Co.	"
1059	90	" "	M.	"	"
1060	90	" "	F.	Maple Grove, Henn. Co.	"
1061	74	Picus villosus, Linn	M.	Minneapolis.	"
1062	85	Sphyrapicus varius, (L.) Bd	M.	"	"
1063	85	" "	F.	"	"
1064	59	Speotyto cunicularia hypogæa, (Bd.) Ridgw	M.	Dakota	"
1065	70	Coccygus erythropthalmus, (Wils) Bd	F.	Near Minneapolis	"
1066	70	" "	F.	"	"
1067	434	Cyanocitta cristata, (L.) Strickl	F.	"	"
1068	434	" "	M.	Minneapolis	"
1069	117	Ceryle alcyon, (L.) Boie	M.	Near Minneapolis	"
1070	117	" "	F.	L. Johannah, Ramsey Co	"
1071	399	Dolichonyx oryzivorus, (L.) Sw	M.	Rice creek, Anoka Co	"
1072	426	Corvus frugivorus, Bartr	M.	Medicine L., Henn. Co	"
1073	414	Icterus spurius, (L) Bp., young.	M.	Minneapolis	"
1074	414	" "	M.	"	"
1075	414	" "	F.	"	"
1076	414	" "	M.	"	"
1077	415	" galbula, (L.) Coues	M.	"	"
1078	401	Agelaeus phoeniceus, (L.) Vieill	M.	Near Sandy L, Anoka Co.	"
1079	404	Xanthocephalus icterocephalus, (Bp.) Bd	M.	Sandy lake, Anoka Co	"
1080	404	" " " "	F.	" "	"
1081	....	Quiscalus purpureus æneus, Ridgw	M.	Minneapolis	"
1082	406	Sturnella magna (L) Sw	M	Near Sandy Lk, Henn Co	"
1083	406	" "	F.	" " "	"
1084	417	Scolecophagus ferrugineus, (Gm) Sw	M.	" " "	"
1085	401	Agelæus phœniceus, (L.) Vieill	F.	" " "	"
1086	261	Harporhynchus rufus, (L.) Caban	F.	Minneapolis	"
1087	158	Sialia sialis, (L.) Haldem	F	"	"
1088	158	" "	M.	"	"
1089	155	Merula migratoria, (L.) Sw. & Rich	....	"	"
1090	155	" "	...	"	"
1091	232	Ampelis garrulus, Linn	M.	Richfield, Hennepin Co.	"
1092	232	" "	F	" "	"
1093	233	" cedrorum. (Viell) Bd	M.	Minneapolis.	"
1094	233	" "	F.	"	"
1095	233	" " Young	M.	"	"
1096	233	" "	M.	"	"
1097	227	Tachycineata bicolor, (Vieill) Caban	M.	L'k Johannah Ramsey Co	"
1098	227	" "	F.	" "	"
1099	318	Loxia curvirostra americana, (Wils.) Coues	F.	Duluth	"
1100	318	" " "	M.	"	"

Register.—Continued.

Collected by.	When collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
Wm. Howling	Oct. 23, 1881.	1884	Wm. Howling	1	By purchase.
"	Jan. 8, 1880.	"	"	1	"
"	1878	"	"	1	"
"	1882	"	"	1	"
"	1881	"	" ...	1	"
"	1879	"	"	1	"
....	....	....	N. L. Bailey.......	1	Presented.
....	....	....	"	1	"
....	....	....	....	1	Young.
....	....	....	....	1	....
Wm. Howling	1882	1884	Wm. Howling.....	1	By purchase.
"	"	"	"	1	"
"	1877	"	"	1	"
"	1882	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	Aug. 3, 1882.	"	"	1	"
"	"	"	"	1	"
"	Sept. 3, 1882.	"	" ...	1	"
"	July 30, 1883.	"	"	1	"
"	July, 1882.	"	"	1	"
"	July 27, 1881.	"	"	1	"
"	Feb. 20, 1880.	"	"	1	"
"	"	"	"	1	"
"	May 12, 1881.	"	"	1	"
"	1880	"	"	1	"
"	June 1, 1881.	"	"	1	"
"	"	"	"	1	"
"	1876	"	"	1	"
"	July, 1881.	"	" ...	1	"
"	July, 1879.	"	"	1	"
"	June, 1883.	"	"	1	"
"	"	"	"	1	"
"	July 20, 1880.	"	"	1	"
"	Aug. 1, 1882.	"	"	2	"
"	1882	"	"	1	"
"	August, 1878.	"	"	3	"
"	Summer of '80	"	"	4	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	2	"
"	July, 1881.	"	"	1	"
"	1881	"	"	3	"
"	June, 1881.	"	"	1	"
"	"	"	"	1	"
"	June 1, 1879.	"	"	1	"
"	May 15, 1879.	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	June 1, 1882.	"	"	1	"
" . .	June 15, 1882	"	"	1	"
"		"	"	1	"
"	....	"	"	2	"
"	Dec. 12, 1881.	"	"	2	"
"	"	"	"	2	"
"	1880	"	"	1	"
"	July, 1880.	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	2	"
"	May 4, 1882.	"	"	1	"
"	"	"	"	1	"
"	1877	"	" ...	1	"
"	"	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen
1101	319	Loxia leucoptera, Gm	M.	Minneapolis	M't'd
1102	319	" "	F.	"	"
1103	220	Pyranga rubra, (L.) Vieill	M.	"	"
1104	220	" "	F.	"	"
1105	220	" "	M.	"	"
1106	220	" " (L.) Vieill	F.	"	"
1107	380	Zamelodia ludoviciana, (L) Coues	M.	Sandy lake, Anoka Co	"
1108	380	" "	F.	" "	"
1109	303	Hesperiphona vespertina, (Cooper) Bp	M.	Minneapolis	"
1110	303	" "	F.	"	"
1111	303	" "	M.	"	"
1112	303	" "	F.	"	"
1113	304	Pinicola enucleator, (L.) Vieill	F.	"	"
1114	304	" "	M.	"	"
1115	304	" "	F.	"	"
1116	304	" " young	M.	"	"
1117	391	Pipilo erythrophthalmus, (L.) Vieill	M.	Sandy lake, Anoka Co	"
1118	391	" "	M.	" "	"
1119	354	Junco hyemalis, (L.) Scl	....	Minneapolis	"
1120	325	Plectrophanes nivalis (L.) Meyer	M.	Osseo, Hennepin Co	"
1121	325	" "	M.	" "	"
1122	305	Carpodacus purpureus, (Gm.) Bd	M.	Minneapolis	"
1123	305	" "	M.	"	"
1124	326	Centrophanes lapponicus, (L.) Caban	M.	Sandy lake, Hennepin Co	"
1125	320	Aegiothus linaria, (L.) Caban	M.	Minneapolis	"
1126	313	Astragalinus tristis, (L.) Caban	M.	"	"
1127	313	" "	F	"	"
1128	349	Zonotrichia albicollis, (Gm.) Bp	M.	"	"
1129	288	Lanius ludovicianus excubitorides, (Sw.) Coues	M.	Anoka, Anoka Co	"
1130	279	Sitta canadensis, Linn	M.	Minneapolis	"
1131	277	Sitta carolinensis, Gmel	M.	"	"
1132	277	" "	F.	"	"
1133	374	Passerella iliaca, (Merrem) Sw	....	Bet. Minneapolis & St. P.	"
1134	374	" "	....	" " "	"
1135	289	Parus atricapillus, Linn	....	Minneapolis	"
1136	289	" "	....	"	"
1137	130	Myiarchus crinitus, (L.) Caban	M.	Bet. Minneapolis & St. P.	"
1138	130	" "	F.	" " "	"
1139	130	" "	M.	" " "	"
1140	130	" "	F.	" " "	"
1141	348	Zonotrichia querula, (Nutt.) Gamb	M.	....	"
1142	345	" leucophrys, (Forst.) Sw	M.	Minneapolis	"
1143	275	Certhia familiaris rufa, (Bartr.) Ridgw	M.	"	"
1144	200	Dendrœca pennsylvanica, (L) Bd	M.	"	"
1145	200	" "	M.	"	"
1146	200	" "	M.	"	"
1147	194	" coronata, (L.) Gray	M.	"	"
1148	194	" "	F.	"	"
1149	101	Trochilus colubris, Linn	F.	"	"
1150	196	Dendrœca blackburniæ, (Gm.) Bd	M.	"	"
1151	181	Helminthophaga chrysoptera, (L.) Bd	F.	"	"
1152	181	" "	M.	"	"
1153	161	Regulus calendula, (L.) Licht	M.	"	"
1154	162	Regulus satrapa, Licht	F.	"	"
1155	162	" "	M.	"	"
1156	217	Setophaga ruticilla, (L.) Sw	F.	Bet. Minneapolis & St. P.	"
1157	217	" "	M.	" " "	"
1158	217	" "	F.	" " "	"
1159	217	" "	M.	" " "	"
1160	....	" "	M.	....	"
1161	....	" "	M.	....	"
1162	170	Geothlypsis trichas, (L.) Caban	M.	Sandy lake, Anoka Co	"
1163	206	Perissoglossa tigrina, (Gm.) Bd	....	" "	"
1164	206	" "	....	" "	"

Register.—Continued.

Collected by.	When Collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	1880	1884	Wm. Howling	1	By purchase.
"	"	"	"	1	"
"	July 14, 1883.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	July 4, 1880.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	Dec., 1879.	"	"	1	"
"	Dec., 1878.	"	"	3	"
"	Dec., 1879.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	Nov., 1880.	"	"	1	"
"	Dec. 25, 1881.	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	"	"	"	1	"
"	June, 1879.	"	"	2	"
"	1879	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	May 28, 1879.	"	"	1	"
			"	1	"
"	Aug. 20, 1879.	"			
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	June 17, 1880.	"	"	1	"
"	....	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	June 16, 1882.	"	"	1	"
"	June 30, 1882.	"	"	1	"
"	June 16, 1882.	"	"	1	"
"	June 30, 1882.	"	"	1	"
....	....	....	....	1	....
Wm. Howling	1879	1884	Wm. Howling....	1	By purchase.
"	"	"	"	1	"
"	May 30, 1882	"	"	1	"
"	June 2, 1879.	"	"	1	"
"	....	"	"	1	"
"	June, 1882.	"	"	1	"
"	May 13, 1881.	"	"	1	"
"	June 3, 1882	"	"	1	"
"	June 7, 1882.	"	"	1	"
"	June 3, 1882.	"	"	1	"
"	"	"	"	1	"
"	May 23, 1880.	"	"	1	"
"	June 14, 1884.	"	"	1	"
"	June 1, 1880	"	"	1	"
"	May 28, 1879.	"	"	1	"
"	June 26, 1882.	"	"	1	"
"	May 28, 1879.	"	"	1	"
....	June 26, 1882	"	"	1	"
....	....	....	....	1	"
....	....	....	....	1	"
Wm. Howling	June 30, 1882.	1884	Wm. Howling	1	"
"	May 29, 1879.	"	"	1	"
"	"	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen
1165	206	Perissoglossa tigrina		Sandy lake Anoka Co.	M't'd
1166	206	" "		" "	"
1167	204	Dendrœca maculosa, (Gm.) Bd	M.	Bet. Minneapolis & St. P.	"
1168	168	Parula americana, (L.) Bp.	M.	Minneapolis.	"
1169	168	" "	M.	"	"
1170	168	" "	F.	"	"
1171	202	Dendrœca striata, (Forst.) Bd	F.	Bet. Minneapolis & St. P.	"
1172	202	" "	M.	" " "	"
1173	203	" æstiva, (Gm.) Bd	M.	Rice creek, Anoka Co.	"
1174	183	Helminthophaga ruficapilla, (Wils.) Bd			"
1175	183	" "			"
1176	203	Dendrœca æstiva, (Gm.) Bd	F.	Rice creek, Anoka Co.	"
1177	213	Myiodoctes pusillus, (Wils.) Bp.	F.	Minneapolis.	"
1178	189	Dendrœca virens, (Gm.) Bd	F.		"
1179	189	" "	F.		"
1180	208	" palmarum, (Gm.) Bd	M.	Minneapolis	"
1181	208	" "	F.	Sandy lake, Anoka Co.	"
1182	208	" "	F.	" "	"
1183	186	Siurus auricapillus, (L.) Sw		Minneapolis.	"
1184	186	" " " "		"	"
1185	187	" nævius, (Bodd.) Coues		"	"
1186	187	" "		"	"
1187	240	Vireosylvia olivacea, (L.) Bp	M.	"	"
1188	245	" gilva, (Vieill) Cass	F.	"	"
1189	240	" olivacea, (L.) Bp	M.	"	"
1190	55	Nyctale tengmalmi richardsoni, (Bp.) Ridgw		Near Minneapolis	"
1191	57	Nyctale acadica, (Gmel.) Bp		"	"
1192	250	Lanivireo solitarius, (V.) Bd	M.	Minneapolis.	"
1193	250	" "	F.	"	"
1194	252	" flavifrons, (V.) Bd	M.	"	"
1195	139	Contopus virens, (L.) Caban	F.		"
1196	148	Hylocichla mustelina, (Gm.) Bd		Minneapolis	"
1197	148	" "		"	"
1198	154	" aliciæ, Bd		"	"
1199	153	" ustulata swainsoni, (Cab.) Ridgw		"	"
1200	349	Zonotrichia albicollis, (Gm.) Bp.	M.	"	"
1201	369	Melospiza palustris, (Wils.) Bd		Near Minneapolis	"
1202	357	Spizella montana, (Forst.) Ridgw	M.	Minneapolis.	"
1203	363	Melospiza fasciata, (Gm.) Scott		"	"
1204	363	" "		"	"
1205	135	Sayornis fuscus, (Gm.) Bd		Sandy lake, Anoka Co.	"
1206	135	" "		" "	"
1207	583	Spatula clypeata, (L.) Boie	M.	Medicine Lake, Henn. Co.	"
1208	583	" "	M.		"
1209	577	Anas obscura, Gmel	F.	Sandy lake, Anoka Co.	"
1210	576	Anas boscas, Linn	M.		"
1211	576	" "	M.		"
1212	576	" "	F.	Sandy lake, Anoka Co.	"
1213	578	Dafila acuta, (L.) Bp	M.	Lk. Johannah, Ramsey Co	"
1214	578	" "	M.	" "	"
1215	578	" " young.	M.	" "	"
1216	585	Mareca americana, (Gm.) Steph.	M.	Lake Amelia, Henn. Co.	"
1217	585	" " young.	M.	" "	"
1218	613	Lophodytes cucullatus, (L.) Reich	M.	Medicine lake, Henn. Co.	"
1219	613	" "	F.	" " "	"
1220	581	Querquedula discors, (L.) Steph	M.	Moore lake, Anoka Co.	"
1221	581	" "	F.	" "	"
1222	579	Nettion carolinensis, (Gm.) Bd	M.	Minneapolis	"
1223	579	" "	M.	"	"
1224	579	" "	M.	"	"
1225	595	Clangula albeola, (L.) Steph.	M.	Sandy Lake, Anoka Co.	"
1226	593	" glaucium americana, (Bp.) Ridgw.	M.		"
1227	593	" " "	M.		"
1228	593	" " "	F.	Lake Minnetonka	"

Register.—Continued.

Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks
Wm. Howling	May 29, 1879.	1884	Wm. Howling	1	By purchase.
"	"	"	"	1	"
"	June 7, 1879.	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	June 4, 1881.	"	"	1	"
" ...	"	"	"	1	"
"	July 28, 1882	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July 28, 1882.	"	"	1	"
"	May 30, 1878	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	June 3, 1879.	"	"	1	"
"	June 14, 1882.	"	"	1	"
"	"	"	"	1	"
"	July 14, 1881.	"	"	1	"
"	"	"	"	1	"
"	June 26, 1882.	"	"	1	"
"	"	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	....	"	"	2	"
"	....	"	"	1	"
"	Spring 1882.	"	"	1	"
"	"	"	"	1	"
"	June, 1882.	"	"	1	"
"	....	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	June 1, 1881.	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July 28, 1882.	"	"	1	"
"	June 20, 1880.	"	"	1	"
" ...	"	"	"	1	"
"	June 15, 1883.	"	"	1	"
"	"	"	"	1	"
"	Spring 1882.	"	"	1	"
"	....	"	"	1	"
"	Sept., 1880.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	1879	"	"	1	"
"	Fall, 1881.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
" . ..	Spring, 1878.	"	"	1	"
"	"	"	"	1	"
"	Fall, 1880.	"	"	1	"
"	"	"	"	1	"
"	Spring, 1877.	"	"	1	"
" ..	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	May 26, 1880.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	Fall, 1879.	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1229	611	Mergus merganser americanus, (Cass.) Ridgw	M.	Long lake, Henn. Co....	M't'd ....
1230	611	" " "	M	Moore lake, Anoka Co..	"
1231	611	" " "	F.	Lake Amelia, Henn. Co..	"
1232	611	" " "	F.	L Johannah, Ramsey Co	"
1233	563	Chen hyperboreus, (Pall) Boie	M.	Windom, Cottonwood Co	"
1234	563	" "	F.	Minneapolis	"
1235	623	Phalocrocorax dilophus,(Sw.& Rich.)Nutt	M.	Rice lake, Hennepin Co	"
1236	698	Colymbus torquatus, Brunn	M.	Lake Minnetonka	"
1237	698	" "	F.	Long lake, Henn Co....	"
1238	698	" " young.	M.	Sandy lake, Anoka Co...	"
1239	615	Pelecanus erythrorhynchus, Gm	M.	New Ulm	"
1240	615	" "	F.	Fisher's Landing, D. T..	"
1241	590	Fulix collaris, (Donov.) Bd	M.		"
1242	580	Fulix marila, (L.) Bd	M.	Sandy lake, Henn. Co....	"
1243	591	Aethyia americana (Eyt.) Bp	M.	Lake Amelia, Henn. Co..	"
1244	592	Aethyia vallisneria (Wils.) Boie	M.	Duluth	"
1245	559	Fulica americana, Gm	...	Medicine lake, Henn. Co.	"
1246	706	Dytes auritus. (L.) Ridgw	M.		"
1247	706	" "	M.		"
1248	706	" "	M	Minneapolis	"
1249	695	Hydrochelidon lariformis surinamensis (Gm.) Ridgw	M.	Long lake, Henn Co....	"
1250	695	" " "	F.	" "	"
1251	670	Larus philadelphiæ, (Ord.) Gray	M.	Richfield, Henn. Co.....	"
1252	670	" "	M.	" "	"
1253	670	" " young.	M	" "	"
1254	670	" " young.	M.	" "	"
1255	670	" "	F.	" "	"
1256	....	" "	....	Lake Minnetonka	"
1257	478	Grus americana, (L.) Temm	M	Cedar Mills	"
1258	487	Ardea herodias, Linn	....	Lake Minnetonka	"
1259	487	" "	....	"	"
1260	495	Nyctiardea grisea nævia, (Bodd.) Allen....	M.	Lake Amelia	"
1261	495	" " "	F.	Windom, Cottonwood Co	"
1262	493	Butorides virescens, (L.) Bp	M.		"
1263	493	" "	M.		"
1264	493	" "	F.	Minneapolis	"
1265	492	Botaurus lentiginosus (Montag.) Steph....	M.	Long lake, Henn. Co....	"
1266	492	" "	F.	" "	"
1267	464	Cupidonia cupido, (L.) Bd	M.		"
1268	464	" "	M.		"
1269	464	" "	M		"
1270	464	" "	F.		"
1271	464	" "	F.		"
1272	464	" " young.	M.	Moore lake, Anoka Co ..	"
1273	463	Pediœcetes phasianellus columbianus, (Ord.) Coues	M.	Dakota	"
1274	465	Bonasa umbrellus, (L.) Steph	M.	Bet. Minneapolis & St. P.	"
1275	465	" "	F.	Minneapolis	"
1276	....	" "	....		"
1277	471	Ortyx virginiana, (L.) Bp	M.	Moore Lake, Anoka Co ..	"
1278	471	" "	F.	" " ..	"
1279	471	" "	F.	" " ..	"
1280	471	" "	F.	" " ..	"
1281	448	Ectopistes migratoria, (L.) Sw	M.	Rice Creek, Anoka Co...	"
1282	448	" "	F.	" " ...	"
1283	451	Zenaidura carolinensis, (L.) Bp	M.	Sandy Lake, Anoka Co.	"
1284	451	" "	F.	" " ...	"
1285	519	Steganopus wilsoni, (Sab.) Coues	M.	" " ...	"
1286	519	" "	M.	" " ...	"
1287	519	" "	M.	" " ...	"
1288	519	" "	M.	" " ...	"
1289	519	" "	F.	" " ...	"
1290	520	Lobipes hyperboreus, (.L) Cuv. (Young)..	M.	Moore Lake, Anoka Co ..	"

Register.—Continued.

Collected by	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	1877	1884	Wm. Howling	1	By purchase.
"	April 10, 1882.	"	"	1	"
"	Nov. 5, 1882.	"	"	1	"
"	Nov. 1, 1879.	"	"	1	"
"	Oct. 15, 1880	"	"	1	"
"	Fall, 1874.	"	"	1	"
"	April 27, 1881.	"	"	1	"
"	Oct. 2, 1880.	"	"	1	"
"	Aug. 28, 1881.	"	"	1	"
"	June 30, 1879.	"	"	1	"
"	April 27, 1880.	"	"	1	"
"	June 5, 1875.	"	"	1	"
"	....	"	"	1	"
"	Sept. 17, 1880.	"	"	1	"
"	Spring, 1878.	"	" ...	1	"
"	Fall, 1879.	"	"	1	"
"	June 13, 1882.	"	"	1	"
"	....	"	"	1	"
"	. ...	"	"	1	"
"	July 14, 1878.	"	"	1	"
"	June 13, 1879.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
J. H. C. Hutchinson	May 15, 1885.	1885	J.H. C. Hutchinson.	1	Presented.
Wm. Howling	Sept. 17, 1878.	1884	Wm. Howling	1	By purchase.
"	June 15, 1877.	"	"	1	"
"	"	"	"	1	"
"	July 21, 1878	"	"	1	"
"	April 28, 1881	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	May 20, 1881.	"	"	1	"
"	June 14, 1880.	"	"	1	"
"	June 20, 1881.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	June, 1882.	"	"	1	"
"	Nov. 20, 1880.	"	"	1	"
"	1880	"	"	1	"
"	1878	"	"	1	"
....	July, 1876.	....	....	1	....
Wm. Howling	August, 1880.	1884	Wm. Howling	1	By purchase.
"	....	"	"	1	"
"	... .	"	"	1	"
"	....	"	"	1	"
"	July 27, 1881.	"	"	2	
"	....	"	"	1	"
"	August, 1880.	"	"	1	"
"	"	"	"	1	
"	July, 1880.	"	"	1	"
"	"	"	"	1	
"	"	"	"	1	
"	"	"	"	1	
"	"	"	"	1	
"	August, 1882.	"	"	1	

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1291	504	Oxyechus vociferus, (L.) Reich	M.	Sandy lake, Hennepin Co	M't'd
1292	504	" "	F.	" "	"
1293	507	Aegialites semipalmatus, Bp			"
1294	560	Gallinula galeata, (Licht.) Bp	M.	L Johannah, Ramsey Co.	"
1295	551	Rallus virginianus, Linn		Minneapolis	"
1296	555	Porzana carolina, (L) Bd	M.	Near Minneapolis	"
1297	555	" "	F.	"	"
1298	....	" " young	F.	Fond du Lac	"
1299	542	Rallus elegans, Aud	M.	Rice creek, Anoka Co.	"
1300	503	Charadrius dominicus, Mull	M.	Sandy lake, Anoka Co.	"
1301	503	" "	F.	" "	"
1302	503	" "	M.		"
1303	503	" "			"
1304	503	" "			"
1305	522	Philohela minor (Gm.) Gray	M.	Rice creek, Anoka Co	"
1306	523	Gallinago media wilsoni, (Temm.) Ridg	M.		"
1307	523	" " "	M.		"
1308	523	" " "	F.	Medicine lake, Henn Co.	"
1309	517	Recurvirostra americana, Gm	M.	Northern Pacific Road	"
1310	547	Limosa fœda, (L.) Ord	M.	Sandy lake, Anoka Co.	"
1311	547	" "	F.	" "	"
1312	537	Symphemia semipalmata. (Gm.) Hartl	M.	Moore lake, Anoka Co.	"
1313	537	" "	F.	Lk Johannah, Ramsey Co	"
1314	539	Totanus melanoleucus, (Gm.) V	M.	Moore lake, Anoka Co.	"
1315	539	Totanus melanoleucus (Gm.) V	M.	" "	"
1316	539	" "	F.	" "	"
1317	539	" "	F.	" "	"
1318	546	Tryngites rufescens, (V.) Cab.	M.	" "	"
1319	530	Pelidna alpina americana, Cass	M.	Sandy lake, Anoka Co.	"
1320	530	" " "	F.	" "	"
1321	541	Rhyacophilus solitarius, (Wils.) Cass	M.	Minneapolis	"
1322	541	" "	F.	"	"
1323	543	Tringoides mascularius, (L.) Gray	M.		"
1324	543	" "	F.		"
1325	541	Ereunetes pusillus, (L) Cass	F.	Sandy lake, Hennepin Co	"
1326	....	" " (young).			"
1327	....	" " (young).			"
1328	390	Cardinalis virginianus, (Briss.) Bp	M.	Virginia	"
1329	390	" "	F.	"	"
1330	160	Sialia arctica, Sw		California	"
1331	156	Hesperocichla nævia, (Gm.) Bd	M.	"	"
1332	126	Tyrannus verticalis, Say	M.	"	"
1333	232	Ampelis garrulus, Linn.	M.	Minneapolis	Skin
1334	232	" "	F.	"	"
1335	232	" "		"	"
1336	303	Hesperiphona vespertina, (Cooper) Bd	M.	"	"
1337	3 3	" "	F.	"	"
1338	348	Zonotrichia querula, (Nutt) Gamb	M.		"
1339	325	Plectrophanes nivalis, (L.) Meyer	M.		"
1340	325	" "	F.		"
1341	233	Ampelis cedrorum, (V.) Bd	F.		"
1342	70	Coccygus erythrophthalmus, (Wils.) Bd	F.		"
1343	380	Zamelodia ludoviciana, (L.) Coues	M.		"
1344	130	Myiarchus crinitus (L.) Cab	M.		"
1345	275	Certhia familiaris rufa, (Bartr.) Ridgw	M.		"
1346	114	Chordeiles popetue, (V.) Bd	M.		"
1347	414	Icterus spurius, (L.) Bp	M		"
1348	414	" " (yonng)	M.		"
1349	137	Contopus borealis, (Sw.) Bd	M.		"
1350	387	Passerina cyanea, (L) Gray	M.	Medicine lake, Henn. Co.	M't'd
1351	227	Tachycineata bicolor (V.) Cab		Lk Johannah, Ramsey Co	"
1352	70	Coccygus erythrophthalmus, (Wils.) Bd	M.	Minneapolis	"
1353	69	Coccygus americanus, (L.) Bp	M.	California	"
1354	325	Plectrophanes nivalis, (L.) Meyer	M.		"
1355	325	" "	F.		"

Register.—Continued.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	July 1, 1880.	1884	Wm. Howling	1	By purchase.
"	June 20, 1879	"	"	1	"
"	....	"	"	1	"
"	1882	"	"	1	"
"	1879	"	"	1	"
"	1877	"	"	1	"
"	"	"	"	1	"
C. W. Hall..........	Sept. 1, 1880.	....	C. W. Hall..........	1	Presented.
Wm. Howling	May 12, 1880.	1884	Wm. Howling.....	1	By purchase.
"	July 1, 1880.	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July, 1880.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	1880	"	"	1	"
"	August, 1878.	"	"	1	"
"	1876	"	"	1	"
"	"	"	"	1	"
"	June 30, 1882.	"	"	1	"
"	May 4, 1882.	"	"	1	"
"	Aug 27, 1881.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	Sept. 27, 1882.	"	"	1	"
"	Summer, 1881.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	1879	"	"	1	"
....	....	....	....	1	....
....	....	....	....	1	....
....	1880	1884	Wm. Howling	2	By purchase.
....	"	"	"	2	"
....	"	"	"	2	"
....	1876	"	"	1	"
....	1878	"	"	1	"
Wm. Howling	....	"	"	3	"
"	....	"	"	4	"
"	....	"	"	3	"
"	....	"	"	6	"
"	....	"	"	6	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	June, 1879	"	"	2	"
"	May 4, 1882.	"	"	2	"
"	July, 1882.	"	"	2	"
....	1876	"	"	1	"
Wm. Howling	....	"	"	2	"
"	....	"	"	3	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1356	325	Plectrophanes nivalis	...		M't'd
1357	308	Hesperiphona vespertina, (Cooper) Bd	M.	Minneapolis	"
1358	308	" "	F.	"	"
1359	124	Tyrannus carolinensis, (L.) Temm	M.	"	"
1360	124	" "	F.	"	"
1361	473	Oreortyx picta, (Dougl.) Bd	M.	California	"
1362	474	Lophortyx californica, (Shaw) Bp	M.	"	"
1363	474	" "	F.	"	"
1364	712	Lunda cirrhata, Pall	M.	Kamschatka	"
1365	96	Melanerpes torquatus, (Wils.) Bp	M.	California	"
1366	96	" "	F.	"	"
1367	95	" formicivorus bairdi, Ridgw	M.	"	"
1368	85	Sphyrapicus varius, (L.) Bd	M.	Bet. Minneapolis & St. P.	"
1369	220	Pyranga rubra, (L.) V	F.	Minneapolis	"
1370	277	Sitta carolinensis, Gm	M.	"	"
1371	....	Quiscalus purpureus æneus, Ridgw	F.	"	"
1372	401	Agelæus phœniceus, (L.) V	M.	"	"
1373	194	Dendrœca coronata, (L.) Gray	M.	"	"
1374	213	Myiodioctes pusillus, (Wils.) Bp	M.		"
1375	403	Agelæus tricolor, (Nutt) Bp	M.	California	"
1376	413	Icterus cucullatus, Sw	M.	"	"
1377	416	Icterus bulocki, (Sw.) Bp	M.	"	"
1378	437	Aphelocoma californica, (Vig.) Cab	M.	"	"
1379	381	Zamelodia melanocephala, (Sw.) Coues	M.		"
1380	386	Passerina amœna, (Say) Gray	M.	California	"
1381	704	Aechmophorus occidentalis, (Laur) Coues	M.	"	"
1382	256	Harporhynchus redivivus, (Gambr.) Cab	M.	"	"
1383	232	Larus delawarensis, Ord	....	Otter Tail Co., Minn	Skin
1384	256	" "	....	Lake Mille Lac, Minn	"
1385	236	Erismatura rubida, (Wils.) Bp	....	Otter Tail Co., Minn	"
1386	246	Corvus corax, L	....	" "	"
1387	257	Buteo borealis, (Gm.) V	....	Borden lake, C. Wing Col	"
1388	196	Otus vulgaris var. wilsonianus	....	Thief river, Minn	"
1389	254	Larus argentatus, Brunn (juv.)	F.	Lake Mille Lac, Minn	"
1390	235	Chaulelasmus streperus, (L.) Gray	F.	Otter Tail Co., Minn	"
1391	249	Dafila acuta, (L.) Bp	M.	" "	"
1392	233	" "	M.	" "	"
1393	237	Fuligula affinis	F.	" "	"
1394	238	"	....	" "	"
1395	184	Steganopus wilsoni, (Cab.) Coues	M.	Norman Co., Minn	"
1396	183	Steganopus wilsoni, (Sab.) Coues (juv.)	M.	" "	"
1397	181	Actiturus bartramius, (Wils.) Bd	M.	" "	"
1398	180	Podilymbus podiceps, (L.) Laur	....	Ada, Minn	"
1399	182	Xanthocephalus icterocephalus, (Bp.) Bd	....	Crookston, Minn	"
1400	245	Larus philadelphiæ, (Ord.) Gray	....	Otter Tail Co., Minn	"
1401	239	Hylotomus pileatus, (L.) Bd	....	" "	"
1402	224	Helminthophaga peregrina, (Wils.) Bd	F.	St. Vincent, Minn	"
1403	188	Turdus fuscescens	....	Ada, Minn	"
1404	250	Hesperiphona vespertina, (Cooper.) Bd	....	Pelican Rapids, Minn	"
1405	252	Picus villosus, L	F.	Lake Mille Lac, Minn	"
1406	163	Sturnella magna, (L.) Sw	....	Ada, Minn	"
1407	219	" "	....	"	"
1408	217	" " (juv.)	....	Norman Co., Minn	"
1409	244	Scolecophagus ferrugineus, (Gm.) Sw	M.	Otter Tail Co., Minn	"
1410	229	Zonotrichia albicollis, (Gm.) Bp	....	" "	"
1411	234	Spizella monticola, (Gm.) Bd	....	" "	"
1412	226	Vireo gilvus	M.	Georgetown, Clay Co. Minn	"
1413	209	Passerculus savanna, (Wils.) Bp	F.	Crookston, Minn	"
1414	214	" "	....	Ada, Minn	"
1415	210	" " (juv.)	M.	Crookston, Minn	"
1416	211	" " (juv.)	....	Georgetown, Minn	"
1417	203	" "	....	Ada, Minn	"
1418	212	Ammodramus caudacutus, (Gm.) Sw	....	St. Vincent, Minn	"
1419	213	Troglodytes ædon, Vieill	....	" "	"
1420	....	Spizella pallida, (Sw.) Bp	....		"

Register.—Continued.

Collected by.	When collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
Wm. Howling	....	1884	Wm. Howling	1	By purchase.
"	March 25, 1884	"	"	2	"
"	"	"	"	2	"
"	June 1, 1881.	"	"	1	"
"	May 26, 1879.	"	"	1	"
....	1881	"	"	1	"
....	"	"	"	1	"
....	"	"	"	1	"
....	1880	"	"	1	"
....	1882	"	"	1	"
....	....	"	"	2	"
....	1882	"	"	1	"
Wm. Howling	1883	"	"	1	"
"	1879	"	"	1	"
"	1878	"	"	1	"
"	June 1, 1879.	"	"	1	"
"	1879	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
....	1882	"	"	1	"
....	1880	"	"	1	"
....	1881	"	"	2	"
....	1876	"	"	1	"
....	....	"	"	1	"
....	1882	"	"	1	"
....	1876	"	"	1	"
....	1877	"	"	1	"
F. L. Washburn...	Oct. 11, 1885.	1885	Geol. & N. H. Sur.	1	....
"	Nov. 5, 1885.	"	" "	1	....
"	Oct 11, 1885.	"	" "	1	....
"	Oct. 10, 1885.	"	" "	1	....
"	Nov. 5, 1885.	"	" "	1	....
"	Sept. 4, 1885.	"	" "	1	....
"	Nov. 1, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	Oct. 28, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	"	"	" "	1	....
"	"	"	" "	1	....
"	Aug. 4, 1885.	"	" "	1	....
"	"	"	" "	1	....
"	"	"	" "	1	....
"	Aug. 10, 1885.	"	" "	1	....
"	Aug. 20, 1885.	"	" "	1	....
"	Oct. 20, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	Aug. 25, 1885.	"	" "	1	....
"	Aug. 10, 1885.	"	" "	1	....
"	Oct. 27, 1885.	"	" "	1	....
"	Nov. 2, 1885.	"	" "	1	....
"	Aug. 6, 1885.	"	" "	1	....
"	"	"	" "	1	....
"	Aug. 4, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	Oct. 12, 1885.	"	" "	1	....
"	Oct. 13, 1885.	"	" "	1	....
"	August, 1885.	"	" "	1	....
"	Aug. 18, 1885.	"	" "	1	....
"	Aug. 6, 1885.	"	" "	1	....
"	Aug. 18, 1885	"	" "	1	....
"	August, 1885.	"	" "	1	....
"	Aug. 6, 1885.	"	" "	1	....
"	Aug. 26, 1885.	"	" "	1	....
"	Aug. 25, 1885.	"	" "	1	....
"	1885	"	" "	1	....

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1421	192	Sitta canadensis, L	...	St. Vincent, Minn	Skin
1422	1	Unio rectus, Lam	...	Mississippi R, Brainerd	
1423	2	Unio luteolus, Lam	....	" "	
1424	3	Unio ventricosus, Bar	....	" "	
1425	4	Unio luteolus, Lam	....	Lk. Minnewaska, Pope Co	
1426	5		....		
1427	6	Limnæa stagnalis, Linn	....	Lk. Minnewaska, Pope Co	
1428	7	Helisoma bicarinatus, Say	....	" "	
1429	8	Planorbelta campanulata, Say	....	" "	
1430	9	Unio cornitus, Bar	...	Lake Pepin, Lake City	
1431	10	Limnæa stagnalis, Linn	....	Minneapolis	
1432	11	Patula alternata, Say	....	"	
1433	12	Unio rectus, Lam	....	Red river, Wilkin Co	
1434	13	Unio luteolus, Lam	....	" "	
1435	14	Unio lacrymosus, Lea	...	" "	
1436	15	Unio alatus, Say	....	" "	
1437	16	Unio rubiginosus, Lea	....	" "	
1438	17	Helicodiscus lineatus, Say	....	Minneapolis	
1439	18	Unio ventricosus, Bar	....	Red river, Wilkin Co	
1440	19		....		
1441	20	Anodonta edentula, Say	....	Red River, Wilkin Co	
1442	21	Unio undulatus, Bar	....	" "	
1443	22	Unio luteolus, Lam	....	White Bear lake	
1444	23	Limnophysa reflexa, Say	....	" " "	
1445	24	Vivipara intertexta, Say	....	" " "	
1446	25	Limnæa stagnalis, Linn	....	" " "	
1447	26	Planorbella campanulata, Say	...	" " "	
1448	27	Helisoma trivolvis, Say	...	" " "	
1449	28	Mesodon multilineata, Say	....	" " "	
1450	29	Limnæa stagnalis, Linn	....	Northern Boundary, east of Vermillion river	
1451	30	Helisoma trivolvis, Say	....	Minneapolis	
1452	31	Physa gyrina, Say	....	"	
1453	32	Helisoma bicarinatus, Say	....	Minnehaha creek, Henn. Co	
1454	33	Unio luteolus, Lam	....	" " "	
1455	34	Limnophysa reflexa, Say	....	Cedar lake, Minneapolis.	
1456	35	" "	....	Lake City	
1457	36	Physa heterostropha, Say	....	Cedar lake, Minneapolis.	
1458	37	Strobila labyrinthica, Say	....	Minneapolis	
1459	38	Hyalina arborea, Say	....	"	
1460	39	Valvata tricannata, Say	....	Cedar lake, Minneapolis.	
1461	40	Stenotrema monodon, Rackett	....	Minneapolis	
1462	41	Planorbella companulata, Say	....	Kegan's Lk, Minneapolis.	
1463	42	Physa heterostropha, Say	..	Minnehaha creek, Henn. Co	
1464	43	Planorbella companulata, Say	....	" " "	
1465	44	Bulinus hypnorum, Linn	....	Minneapolis	
1466	45	Mesodon multilineata, Say	....	"	
1467	46	Succinea obliqua, Say	....	"	
1468	47	Succinea ovalis, Gould	....	"	
1469	48	Vallona pulchella, Mull	....	"	
1470	49	Clonella subcylindrica, Linn	....	"	
1471	50	Somatogyrus subglobosus, Say	....	Miss. R., Ft. Snelling	
1472	51	Unio alatus, Say	....	Mississippi R., Dresbach, Winona Co	
1473	52	Unio plicatus, Le Sueur	....	" " "	
1474	53	Unio luteolus, Lam	....	" " "	
1475	54	Unio rectus, Bar	..	" " "	
1476	55	Unio metanervus, Raf	....	" " "	
1477	56	Unio ligamentinus, Lam	..	" " "	

Register.—Continued.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
F. L. Washburn....	Aug. 26, 1885.	1885	Geol. & N. H. Sur.	1	....
N. H. Winchell....	Sept., 1877.	Sept., 1877.	" "	14	....
"	"	"	" "	1½	....
"	"	"	" "	20	....
" ...	....	....	" "	4	....
....	....	....		.....	....
N. H. Winchell....	....	....	Geol. & N. H. Sur.	1	....
"	....	....	" "	1	....
"	....	....	" "	6	....
Frank Patton......	1884	June, 1885.	Uly. S. Grant.. ...	2	Presented.
Uly. S. Grant......	Sept., 1884.	"	"	20	"
" ...	"	"	"	25	"
N. H. Winchell....	....	....	Geol. & N. H. Sur.	3	20 miles north of Breckenridge.
"	....	....	" "	6	" "
"	....	....	" "	1	" "
"	....	....	" "	2	" "
"	....	....	" "	1	" "
Uly. S. Grant......	July, 1885.	July, 1885.	" "	.....	....
N. H. Winchell....	....	....	" "	8	20 miles north of Breckenridge.
....	....	....		.....	....
N. H. Winchell....	....	....	Geol. & N. H. Sur.	2½	20 miles north of Breckenridge.
"	....	....	" "	4	" "
"	Aug., 1877.	Aug., 1877.	" "	1	....
"	"	"	" "	1	....
"	"	"	" "	75	....
"	"	"	" "	5	....
"	"	"	" "	2	....
" ...	"	"	" "	16	....
"	"	"	" "	1	....
"	Oct., 1878.	Oct., 1878.	" "	5	....
Uly. S. Grant......	Sept., 1884	June, 1885.	Uly. S. Grant.......	15	Presented.
"	"	"	"	20	"
"	June 21, 1885.	June 21, '85.	Geol. & N. H. Sur.	.....	....
O. W Oestlund . ..	July 31, 1885	July 31, '85.	" "	.....	....
Uly. S. Grant	June 23, 1885.	June 23, '85.	" "	.....	....
Frank Patton......	1884	June, 1885.	Uly. S. Grant......	12	Presented.
Uly. S. Grant......	June 23, 1885.	June 23, '85.	Geol. & N. H. Sur.	.....	....
"	July, 1885.	July, 1885.	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
" ...	"	"	" "	.....	....
"	June 22, 1885.	June 22, '85.	" "	.....	....
"	June 21, 1885.	June 21, '85.	" "	.....	....
"	"	"	" "	.....	....
"	July, 1885.	July, 1885.	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
"	Aug , 1885.	Aug., 1885.	" "	.....	....
....	....	....	" "	2	....
....	....	....	" "	3	....
....	....	....	" "	1	Very old, abnormal and distorted.
....	....	....	" "	1	....
....	....	....	" "	1	....
....	....	....	" "	2	....

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1478	57	Unio occidens, Lea		Mississippi R., Dresbach, Winona Co	
1480	59	Unio æsopus, Green		" " "	
1481	60	Unio cornutus, Bar		" " "	
1482	61	Unio ellipsis, Lea		" " "	
1483	62				
1484	63	Unio ebenus, Lea		Mississippi R., Dresbach, Winona Co	
1485	64	Unio luteolus, Lam		Min'sota City, Winona Co	
1486	65	Lioplax subcarinata, Say		Minnesota R., Ft. Snelling	
1487	66	Mesodon multilineata, Say		Minneapolis	
1488	67	" "		"	
1489	68	Planorbella campanulata, Say		Cedar lake, Minneapolis	
1490	69	Limnæa stagnalis, Linn		Lake Bertram, Wright Co	
1491	70	Unio luteolus, Lam		Lake Minnetonka	
1493	72	Margaritana confragosa, Say		Minnesota R., Ft. Snelling	
1494	73	Unio lævissimus, Lea		" "	
1495	74	Unio alatus, Say		" "	
1496	75	Anodonta corpulenta, Cooper		" "	
1497	76	Andonta imbecillis, Say		" "	
1498	77	Margaritana complanata, Bar		" "	
1499	78	Unio gracilis, Bar		" "	
1500	79	Unio elegans, Lea		" "	
1501	80	Unio zigzag, Lea		" "	
1502	81	Unio luteolus, Lam		" "	
1503	82	Unio rectus, Lam		Rum R., Anoka, Anoka Co	
1504	83	Unio gibbosus, Bar		Minnesota R., Ft. Snelling	
1505	84	Unio anodontoides, Lea		" "	
1506	85	Unio cornutus, Bar		" "	
1507	86	Limnæa stagnalis, Linn		" "	
1508	87	Unio parvus, Barnes		" "	
1509	88	Unio luteolis, Lam		Miss. R., Anoka, Anoka Co	
1510	89	Unio ventricosus, Bar		Rum " "	
1511	90	Anodonta ferussaciana, Lea		" " "	
1512	91	Unio luteolus, Lam		" " "	
1513	92	Unio solidus, Lea		Mississippi R. Ft. Snelling	
1514	93	Unio tuberculatus, Bar		Minnesota R., Ft. Snelling	
1515	94	Unio ventricosus, Bar		" "	
1516	95	Unio securis, Lea		" "	
1517	96	Unio plicatus, LeS		" "	
1518	97	Unio lacrymosus, Lea		" "	
1519	98	Pisidium abditum, Hald		" "	
1520	99	Sphærium transversum, Say		" "	
1521	100	Unio trigonus, Lea		" "	
1522	101	Physa heterostropha, Say		Mississippi R., "	
1523	102	Unio metanervus, Raf		Cumber'nd R. Nash. Tenn	
1524	103	Unio trigonus, Lea		Mississippi R., Moline, Ill	
1525	104	Unio crassidens, Lam		Duck river, Tenn	
1526	105	Unio perdix, Lea		" "	
1527	106	Lithasia geniculata, Hald		Cumber'nd R. Nash. Tenn	
1528	107	Angitrema armigera, Say		" "	
1530	109	Io spinosa, Lea		Holston R., Knoxville, T.	
1531	110	Pleurocera subulare, Lea		Miss. R., Anoka. Anoka Co	
1532	111	" "		Minnesota R., Ft. Snelling	
1533	112	Unio graniferus, Lea		Miss R., Ft. Snelling	
1534	113	Patula striatella, Anth		Minneapolis	
1535	114	Bythinella obtusa, Lea		Minnesota R., Ft Snelling	
1536	115	Limnæa megasoma, Say		Knife lake, Lake Co	
1537	116	Sphærium striatinum, Lam		Minnesota R., Ft. Snelling	
1538	117	" "		Miss. R., Anoka, Anoka Co	
1539	118	Physa heterostropha, Say		" "	
1540	119	Margaritana marginata, Say		Minnesota R., Granite F.	
1541	120	" rugosa, Bar		" "	
1542	121	Unio alatus, Say		" "	

Register.—Continued.

Collected by.	When collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
			Geol. & N. H. Sur.	6	
			" "	13	
			" "	2	
			" "	12	
			" "		
			" "	100	
N. H. Winchell			" "	1	
Uly. S. Grant	Aug., 1885.	Aug., 1885.	" "		
H. V. Winchell	June, 1885.	June, 1885.	" "		Without revolving lines.
"	"	"	" "		Deformed.
Uly. S. Grant	"	"	" "		
H. V. Winchell	June 29, 1885.	July 1, 1885.	H. V. Winchell	12	Presented.
Uly. S. Grant	Aug., 1885.	Aug., 1885.	Geol. & N. H. Sur.		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
"	"	"	" "		
R. E. Call		Nov. 9, '85.	R. E. Call	3	Presented.
"		"	"	5	"
"		"	"	1	"
"		"	"	1	"
"		"	"	9	"
"		"	"	13	"
"		"	"	1	"
Uly. S. Grant	Aug., 1885.	Aug., 1885.	Geol. & N. H. Sur.		
"	"	"	" "		
"	"	"	" "		
"	July, 1885.	July, 1885.	" "		
"	Aug., 1885.	Aug., 1885.	" "		
N. H. Winchell	Sept. 28, 1878.	Sept. 28, '78.	" "	2	
Uly. S. Grant	Aug., 1885.	Aug., 1885.	" "		
"	"	"	" "		
"	"	"	" "		
C. W. Hall		Dec., 1885.	C. W. Hall	1	Presented
"		"	"	1	"
"		"	"	6	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1543	122	Unio tuberculatus, Bar	....	Minnesota R., Granite F.	....
1544	123	Unio ventricosus, Bar	....	" "	....
1545	124	Unio ligamentinus, Lam	....	" "	....
1546	125	Unio plicatus, LeS	....	" "	....
1547	126	Unio rectus, Lam	....	" "	....
1548	127	Anodonta edentula, Say	....	" "	....
1549	128	Helisoma trivolvis, Say	....	" "	....
1550	129	Limnæa stagnalis, Linn	....	" "	....
1552	131	Planorbella campanulata Say	....	Lake Bertram, Wright Co	....
1553	132	Helisoma bicarinatus, Say	....	" "	....
1554	133	" trivolvis, Say	....	" "	....
1555	134	Valvata tricarinata, Say	....	" "	....
1556	135	Unio undulatus, Bar	....	Des Moines, Iowa	....
1557	136	Unio ligamentinus, Lam	....	" "	....
1558	137	Unio rectus, Lam	....	" "	....
1559	138	Unio gibbosus, Bar	....	" "	....
1560	139	Unio luteolus, Lam	....	" "	....
1561	140	Unio ventricosus, Bar	....	" "	....
1562	141	Margaritana complanata, Bar	....	" "	....
1563	142	Mesodon albolabris, Say	....	" "	....
1564	143	Sphærium striatinum, Lam	....	Lake Bertram, Wright Co	....
1565	144	" rhomboideum, Say	....	" "	....
1566	145	" partumeium, Say	....	Minneapolis	....
1567	146	" occidentale, Prime	....	"	....
1568	147	Carychium exiguum, Say	....	"	....
1569	148	Unio luteolus, Lam	....	Minnehaha Crk, Henn. Co	....
1570	149	Helisoma trivolvis, Say	....	Minneapolis	....
1571	150	" "	....	St. Anthony Park, Ramsey Co.	....
1572	151	" "	....	Minnesota R., Ft. Snelling	....
1573	152	" "	....	International Boundary, east of Vermillion R.	....
1574	153	Planorbella campanulata, Say	....	Minneapolis	....
1575	154	Gyraulus deflectus, Say	....	"	....
1576	155	Physa gyrina, Say	....	"	....
1577	156	" "	....	Mississippi R., Ft. Snelling	....
1578	157	" "	....	Mississippi R., Anoka	....
1579	158	Sphærium striatinum, Lam	....	Rum River, Anoka	....
1580	159	" "	....	Minnehaha Crk, Henn. Co	....
1581	160	Limnophysa caperata, Say	....	Minneapolis	....
1582	161	Gyraulus deflectus, Say	....	Lake Bertram, Wright Co	....
1583	162	Pleurocera subulare, Lea	....	Rum River, Anoka	....
1584	163	Amnicola cincinnatiensis, Auth	....	" "	....
1585	164	Amnicola cincinnatiensis, Auth	....	Minnesota R., Ft. Snelling	....
1586	165	" porata, Say	....	" "	....
1587	166	" "	....	Cedar lake, Minneapolis.	....
1588	167	Unio tuberculatus, Bar	....	Mississippi R., Dresbach, Winona Co	....
1589	168	Anodonta grandis, Say	....	Minnesota City	....
1590	169	" "	....	Zumbro River, Wab. Co.	....
1591	170	Helisoma bicarinatus, Say	....	Buffalo lake, Wright Co.	....
1592	171	Planorbella campanulata, Say	....	" "	....
1593	172	Valvata tricarinata, Say	....	" " "	....
1594	....	Ursus americanus, Pallas	..	.... Minn.	M't'd ....
1595	....	Bos americanus, Gm. (albino.)			"
1596	....	Ovis montana, Cuv	M.	Maiden, M. T.	"
1597	....	Antilocapra americana, Ord	M.	Bismark, D. T.	"
1598	....	" " Head.	M.	" "	"
1599	....	" " (young) .... "	M.	" "	"
1600	....	" " "	M	Montana	"
1601	....	Cariacus virginianus, (Bodd.) Gray.. "	M.	Minnesota	"
1602	....	" " "	M.	"	"
1603	....	" " (young). "	M.	Near Minneapolis	"

Register.—Continued.

Collected by.	When Collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
C. W. Hall........	....	Dec., 1885.	C. W. Hall.........	1	Presented.
"	....	....	"	4	"
"	....	....	"	5	"
"	....	....	"	1	"
"	....	....	"	8	"
"	....	....	"	1	"
"	....	....	"	8	"
"	....	....	"	3	"
H. V. Winchell....	June 29, 1885.	July 1, '85.	H. V. Winchell....	4	"
"	"	"	"	7	"
"	"	"	"	5	"
"	"	"	"	1	"
Uly. S. Grant......	1883	Dec. 29, '85.	Uly. S. Grant......	8	"
"	1884	"	"	8	"
"	"	"	"	6	"
"	"	"	"	4	"
"	"	"	"	8	"
"	"	"	"	5	"
"	"	"	"	6	"
"	"	"	"	4	"
H. V. Winchell....	June 29, 1885.	July 1, '85.	H. V. Winchell....	2	"
"	"	"	"	1	"
O. W. Oestlund....	July, 1885.	July, 1885.	Geol. & N. H. Sur.	......	....
Uly. S. Grant......	"	"	" "	......	....
"	"	"	" "	......	....
O. W. Oestlund....	"	"	" "	......	Very abnormal.
Uly. S. Grant......	"	"	" "	......	....
"	"	"	" "	......	....
"	Aug., 1885.	Aug., 1885.	" "	......	....
N. H. Winchell....	Oct., 1878.	Oct., 1878.	" "	......	....
Uly. S. Grant......	June, 1885.	June, 1885.	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	Aug., 1885.	Aug., 1885.	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
O. W. Oestlund....	July 31, 1885.	July 31, '85.	" "	......	....
Uly. S. Grant......	June, 1885.	June, 1885.	" "	......	....
H. V. Winchell....	June 29, 1885.	July 1, '85.	H. V. Winchell....	2	Presented.
Uly. S. Grant......	Aug., 1885.	Aug., 1885.	Geol. & N. H. Sur.	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
....	....	....	" "	1	....
N. H. Winchell....	....	....	" "	2	....
"	Oct. 18, 1875.	Oct. 13, '75.	" "	1	....
Warren Upham....	....	....	" "	8	....
"	....	....	" "	15	....
"	....	....	" "	30	....
C. L. Herrick......	Jan. 5, 1885.	1885	" "	1	....
....	....	"	John S. Pillsbury..	1	Presented.
....	Dec., 1882.	1884	Wm. Howling.....	1	By purchase.
....	Feb , 1883.	"	"	1	"
....	"	"	"	2	"
....	"	"	"	1	"
....	1878	"	"	1	"
Wm. Howling	1882	"	"	5	"
" ...	1875	"	"	1	" Double growth of horn.
"	1876	"	"	1	By purchase.

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1604	....	Cariacus virginianus.................. "	M.	Minnesota....................	"
1605	....	" " (young)....... "	....	Hinckley, Minn...........	"
1606	....	Cervus macrotis, Say................. "	M.	Montana..................	"
1607	...	Rangifer caribou, Aud. and Bach ... "	F.	Canada..................	"
1608	....	Canis lupus, L............................	...	Dakota..................	"
1609	...	Castor fiber, L............................	M.	Minnesota................	"
1610	....	Procyon lotor, (L.) Storr....................	M.	Near Minneapolis.........	"
1611	....	" "	F.	Rice lake, Anoka Co	"
1612	....	Taxidea americana, (Bodd.) Baird.........	M.	Nicollet Island. M'p'ls...	"
1613	....	Fiber zibethicus, (L.) Cuv............	....	Lake Calhoun, M'p'ls....	"
1614	....	Mephitis mephitica, Baird..................	F.	Minneapolis.	"
1615	....	" " (6 mo. old).............	M.	Moore Lake, Anoka Co..	"
1616	....	" " (young)	....	" " ..	"
1617	....	" " "	....	" " ..	"
1619	....	Arctomys monax, (L.) Gm..................	M.	Minneapolis.......	"
1620	....	" "	F.	"	"
1621	....	Putorius vison, Rich.......................	M.	Coon creek, Anoka Co ...	"
1622	....	" "	F.	" "	"
1623	....	" ermineus, Cuv. (Summer)..... ...	M.	Minneapolis.......	"
1624	....	" " (Autumn)	M.	"	"
1625	....	" " "	F.	"	"
1626	....	" " (Winter)................	M.	"	"
1627	....	Sciurus ludovicianus, Custis...............	....	"	"
1628	....	" hudsonius, Pallas..................	....	"	"
1629	....	" carolinensis, Gm.....................	....	"	"
1630	....	Sciuropterus volans, (L.) Coues............	....	....	"
1631	....	Mus decumanus, Pallas..........	F.	Minneapolis.......	"
1632	....	Spermophilus franklini, Cuv..............	M.	"	"
1633	....	Ursus americanus, Pallas, (young)	F.	"	"

Register.—Concluded.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	1875	1884	Wm. Howling.....	1	By purchase. Curious shaped horn.
....	....	....	....	1	....
....	1884	1884	Wm. Howling	2	By purchase.
....	1876	"	"	1	"
....	....	"	....	2	"
Wm. Howling	Jan. 14, 1882.	"	Wm. Howling	1	"
"	1876	"	"	1	"
"	1877	"	"	1	"
"	July, 1875.	"	"	1	"
"	1880	"	"	2	"
"	"	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	"	"	"	1	"
"	1882	"	"	1	"
"	"	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	3	"
"	1876	"	"	1	"
"	1877	"	"	2	"
"	....	"	"	2	"
"	1875	"	"	2	"
"	June 13, 1873.	"	"	1	" 5 legs.
"	1877	"	"	1	"
" .	1874	"	"	1	"

GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

N. H. WINCHELL, STATE GEOLOGIST.

THE BIBLIOGRAPHY

OF THE

FORAMINIFERA

RECENT AND FOSSIL,

INCLUDING EOZOON AND RECEPTACULITES.

1565—JAN. 1, 1886.

BY ANTHONY WOODWARD.

Part VI of the annual report of progress for the year 1885.

ST. PAUL:
J. W. CUNNINGHAM & CO., STATE PRINTERS,
16 West Fourth Street.
1886.

NOTE.—This paper is introductory to a contemplated work on the foraminifera and other microscopic organisms of the Cretaceous of Minnesota. According to present plans this work will be done by Messrs. Woodward and Thomas, jointly, and it will be published in one of the volumes of the final report of the survey.

N. H. W.

PREFACE.

This bibliography, which is the result of five years of research, is based largely on facilities afforded by the libraries of the American Museum of Natural History and of the New York Academy of Sciences,—facilities which are not enjoyed by many scientific students. At the beginning I had no idea of presenting this work to the scientific world. When I began the study of the foraminifera I had no knowledge whatever of that which had been done in this branch of science. After I commenced looking up the subject the references accumulated so rapidly that I thought it might be well to collect and put them in shape so that they might be useful to others as well as to myself.

After three years' labor I applied to Mr. H. B. Brady, F. R. S., for information pertaining to the subject. He at once informed me that he had in press a bibliography of the same character, and kindly offered to give me any assistance he could.

When the British Association for the Advancement of Science met at Montreal, in 1884, I met in New York Mr. James Thomson, F. G. S., a member from Scotland, to whom I spoke of my work, asking his advice about proceeding with it. He urged me to continue, and to finish it, as it would become accessible to a great number of workers who could not possess the valuable monograph of Mr. H. B. Brady.

I do not presume that this list is complete; since titles are liable to be found in obscure publications that have not fallen

under my notice. Some of those that are here listed may at first appear not to pertain to the subject, but many of the discussions, criticisms, notes, etc., to which reference has been made, although some of them are in general works on microscopy, are of much interest and value to the student, and will be found useful to those who have not access to large libraries.

The list is divided under the following heads:

(1)—Eozoon. (2)—North and South America, Bermuda, Leeward and Windward Islands. (3)—England, Ireland, Scotland and Wales. (4)—France and Italy. (5)—Austro-Hungary, Belgium, Denmark, Finland, Germany, Holland, Netherlands, Norway, Sweden, Switzerland. (6)—Russia and Turkey. (7)—Africa and Asia. The authors names are then arranged alphabetically and their works according to the date of publication.

I must ask those who may notice omissions or detect errors, to kindly inform me of the same so that I may be able to make corrections in a completed supplement.

I am under great obligations, and return my sincere thanks to the following gentlemen who have rendered me invaluable assistance in sending manuscript lists of their papers.

Rev. P. B. Brodie, M. A., F. G. S., R. V., Warwich, England; Dr. R. Haensler, Sussex, England; Prof. W. C. Williamson, Manchester, England; H. J. Carter, F.R. S., Budleigh, Salterton Devon, England; Joseph Wright, F. G. S., Belfast, Ireland; Sir J. W. Dawson, Montreal, Canada; R. J. Lachmere Guppy, F. L. S., F. G. S., Trinidad; M. O. Terquem, Paris, France; Dr. A. Schneider, Breslau; Prof. Dr. H. B. Geinitz, Dresden, Germany; Prof. Dr. Leopold Auerbach, Breslau, Germany; Prof. Hertwig, Bonn, Germany; Prof. Dr. Carl W. Gumbel, Munich, Germany; Prof. Dr. Haeckel, Jena, Germany; Prof. Dr. Valerian Mœller, St. Petersburg, Russia.

It is hoped that this bibliography will be of some service to the student. The writer will then feel that his years of tedious and constant labor have been well repaid.

ANTHONY WOODWARD.

New York, March 1, 1886.

CONTENTS.

PART I.

EOZOON.

EOZOON.

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The author treats more especially of the nummulinæ layer and the canal-system of the "intermediate skeleton," and concludes by summarizing the general evidence in favor of the organic origin of *Eozoon*. (Nicholson in White and Nicholson's Bib. p. 87.)

CARPENTER, W. B. Final Note on Eozoon canadense. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol xiv, pp. 371-372. 1874.

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A recapitulation of the principal facts in support of the belief that *Eozoon canadense* is a *Foraminifer*. (White's Bib. p. 87.)

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CARPENTER, W. B. Further Researches on Eozoon canadense. <*Nature*, vol. x, p. 390. 1874.

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CARPENTER, W. B. Further Researches on Eozoon canadense. <*Rep. Brit. Assoc. for* 1874, Section, pp. 136, 137. 1875.

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CARPENTER, W. B. Supposed New Laurentian Fossil. <*Nature*, vol. xiv, p. 68. 1876.

CARPENTER, W. B. Note on Otto Hahn's Microgeological Investigation of Eozoon canadense. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xvii, pp. 417-422. 1876.

CARPENTER, W. B. The Eozoon canadense. <*Nature*, vol. xx, pp. 328-330. 1879.

CARPENTER, W. B. Eozoon canadense. <*The Microscope and its Revelations*, Sixth Edition, pp. 587-592. 1881.

CARPENTER, W. B., and J. W. Dawson. The Eozoon canadense. <*Nature*, vol. xx, p. 328. 1879.

CARTER, H. J. On the structure called Eozoon canadense, in the Laurentian Rocks of Canada. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xiii, pp. 189-193. 1874.

Gives reasons for believing that *Eozoon* is not of organic origin. (Nicholson in White and Nicholson's Bib. p. 88)

CARTER, H. J. On the structure called Eozoon canadense in the Laurentian Limestones of Canada. <*Ann., and Mag. Nat. Hist*, ser. 4, vol. xiii, pp. 376–378, with 1 engraving. 1874.

CARTER, H. J. Relation of the Canal-system to the Tubulation in the Foraminifera, with reference to Dr. Dawson's "Dawn of Life." <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xvi, pp. 420–424. 1874.

Discusses the minute structure of the test of recent *Foraminifera*, as bearing on the nature of *Eozoon canadense*. (Nicholson in White and Nicholson's Bib. p. 88)

CARTER, H. J. Eozoon canadense not a Foraminifer or calcareous Rhizopod secretion. <*Amer. Journ. Sci*., vol. vii, 3d ser., pp. 437, 438. 1874.

CREDNER, H. Die Gliederung der eozoischen (vorsilurischen) Formationsgruppe Nord-Amerikas. <*Zeit. Gesam. Naturwissenschaften*, 32, pp 353–405. 1868.

DANA, J D. On the History of Eozoon canadense. <*Am. Journ. Sci.*, vol. xi, 2d ser., pp. 344–362, wood cuts and 1 plate. 1865.

This article appears in the Journal without a name; *i. e.* editorially. This history embraces a full discussion of the subject, and includes a complete description and illustration of the structure of the fossil, and the chemical composition of specimens. (White in White and Nicholson's Bib. p. 22.

DANA, J. D. Manual of Geology. Second edition, pp. 158, 159. 1875.

D'ARCHIAC. Note sur l'existence des restes organiques dans les Roches Laurentiennes du Canada. <*Comptes Rendus*, vol. liii, pp. 192–194. 1865.

A note presented by M. D'Archiac on the part of Dr. W. B. Carpenter as to the discovery of *Eozoon canadense*. (Nicholson in White and Nicholson's Bib. p. 90)

DAWSON, J. W. On the Structure of certain Organic Remains in the Laurentian Limestones of Canada. <*Quart. Journ. Geol. Soc. Lond.*, vol xxi, pp. 51–59, pls. vi, vii. 1865.

The author gives a detailed description of the structure of the bodies described by Sir. William Logan as being organic and as occurring in the Lower Laurentian Limestones. (Quart Journ. Geol. Soc, vol. xxi, p. 45.) The generic name of Eozoon is proposed for these, and the single form described is discussed under the name of *Eozoon canadense*. The author further concludes that Eozoon is probably to be regarded as an ancient type of the *Foraminifera*. (Nicholson in White and Nicholson's Bib. p 93.)

DAWSON, J. W., and W. B. CARPENTER. Notes on Fossils recently obtained from the Laurentian Rocks of Canada, and on objections to the Organic nature of Eozoon. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxiii, pp. 257–265, 2 plates. 1865.

DAWSON, J. W. Notes on fossils recently obtained from the Laurentian Rocks of Canada, and objections to the Organic nature of Eozoon. <*Amer. Journ. Sci.*, vol. xliv, 2d ser., pp. 367–376. 1867.

The article also contains notes by W. B. Carpenter; and "Summary" and "conclusion" of King and Rowney, on the same subject; the latter gentlemen opposing, and the former advocating, the organic origin of Eozoon. (White in White and Nicholson's Bib. p. 22.)

DAWSON, J. W. On certain Organic remains in the Laurentian Limestone of Canada. <*Canad. Nat.*, new ser., vol. 11, pp. 99–111, 127, 128. 3 wood cuts. 1865.

A reprint from the *Quart. Journ. Geol. Soc. Lond.*, 1865, with some additional notes. A short appendix to the paper follows at pp. 127, 128. (Nicholson in White and Nicholson's Bib. p. 93.)

DAWSON, J. W. Notes on fossils recently obtained from the Laurentian Rocks of Canada, and on objections to the Organic nature of Eozoon, with notes by W. B. Carpenter, M. D., F. R. S. <*Quart. Journ. Geol. Soc. Lond*, vol. xxiii, pp. 257–265, pls. xi, xii. 1867.

In the first part of this memoir, Dr. Dawson gives an account of the general appearance and microscopic structure of a specimen of *Eozoon canadense*, found in the Laurentian rocks at Tudor, in which the chambers of the skeleton are filled with a dark colored coarse limestone. The author next deals with certain specimens from Long Lake and Wentworth, and also from Madoc, and concludes by reviewing the objections brought forward by Professors King and Rowney to the organic nature of Eozoon. Dr. W. B. Carpenter adds a note on the appearances presented by thin slices of specimens of *Eozoon* in which the canal-system has been infiltrated with transparent carbonate of lime. (Nicholson in White and Nicholson's Bib. p. 93.)

DAWSON, S. W., and W. B. CARPENTER. Notes on Fossils recently obtained from the Laurentian Rocks of Canada, and objections to the organic nature of Eozoon. <*Amer. Journ. Sci.*, vol. xliv, 2d ser., pp. 367–376. 1867.

DAWSON, J. W., and W. B. CARPENTER. On new specimens of Eozoon canadense, with a reply to the objections of Professors King and Rowney. <*Amer. Journ. Sci*, vol. xlvi, 2d ser., pp. 245–255, 2 plates. 1868.

DAWSON, J. W. On new specimens of Eozoon canadense, with a reply to Professors King and Rowney; with notes by W. B. Carpenter. <*Amer. Journ. Sci.*, vol. xlvi, 2d ser., pp. 245–257, 2 plates. 1868.

The authors advocate the organic origin of Eozoon. (Nicholson in White and Nicholson's Bib. p. 92.)

DAWSON, J. W. Remarks on Eozoon canadense. <*Nature*, vol. x, p. 103. 1 wood cut. 1874.

DAWSON, J. W. Notes on the occurrence of Eozoon canadense, at Cote St. Pierre. <*Nature*, vol. xii, p. 79. 1875. (Abstract.)

DAWSON, J. W. On the Eozoon canadense. <*Nature*, vol. iii, p. 287. 1871.

DAWSON, J. W. The Story of the Earth and Man.

(Remarks on Eozoon chapter ii, iii, pp. 17–38) pp. 403, 800. London, 1873.

DAWSON, J. W. The Dawn of Life: being the history of the oldest known fossil remains, and their relations to geological time and to the development of the animal kingdom, pp. 239, with 8 plates and 49 wood cuts. London, 1875.

This work deals principally with the history of the discovery of *Eozoon canadense*, and with all the known facts bearing on its structure and nature. The author first gives a descriptive sketch of the Laurentian formation, accompanied by sections, and a colored map showing the distribution of the Laurentian Limestones in the counties of Ottawa and Argenteuil. Next, a history is given of the various steps which led to the discovery of *Eozoon* and a record of its interpretation by Carpenter and the author

Thirdly, a chapter is devoted to a consideration of the minute structure exhibited by *Eozoon;* and this is compared with the structure of recent *Foraminifera*. The fifth chapter is concerned with the manner in which *Eozoon* has been preserved, and with a consideration of the processes of fossilization by infiltration in general. In the sixth chapter, the author deals with the successors and contemporaries of *Eozoon*, with special reference to *Archæosphærina*, *Stromatopora*, *Caunopora*, and *Receptaculites*. Another chapter is devoted to a consideration of the various objections which have been urged against the organic nature of *Eozoon;* and a final chapter treats of certain speculative considerations which may be drawn from the study of this fossil. (Nicholson in White and Nicholson's Bib. p. 95.)

DAWSON, J. W. On Mr. Carter's objections to Eozoon. <*Ann., and Mag. Nat. Hist*, ser. 4, vol. xvii, pp. 118, 119. 1876.

DAWSON, J. W. Notes on the Phosphates of the Laurentian and Cambrian Rocks of Canada. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxxii, pp. 285–291. 1876.

Concludes that the phosphatic material found in these rocks in Canada is of organic origin, and has been produced by the agency of marine invertebrates. (Nicholson in White and Nicholson's Bib. p. 95.)

DAWSON, J. W. Notes on the Occurrence of Eozoon canadense at Cote St. Pierre. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxxii, pp. 66–74, plate x, with 4 wood cuts. 1876.

The author gives an account of the nature and arrangement of the strata at Cote St. Pierre, with special reference to the appearance presented by *Eozoon* as occurring *in situ*. Numerous chrysotile veins pass through the limestone, but the author concludes that they are altogether subsequent to the fossil in origin. The close resemblance of weathered specimens to *Stromatopora* is insisted upon; and two new forms of *Eozoon canadense* are described as var. *minor* and var. *acervulina*. The limestone sometimes contains numerous little globose casts of chamberlets, single or attached in groups, each of which possesses the structure of the "proper wall" of *Eozoon*. For these the author proposes the name of *Archæosphærinæ*. (Nicholson in White and Nicholson's Bib. pp. 95, 96.)

DAWSON, J. W. On some new specimens of Fossil Protozoa from Canada. <*Proc. Am. Assoc. Adv. Sci.*, vol. xxiv, pp. 100–106, wood cuts. 1876.

The author gives general description and illustration of *Eozoon canadense*, and also *Foraminifera*, from Cretaceous rocks. He advocates the organic origin of *Eozoon*. (White in White and Nicholson's Bib. p. 22.)

DAWSON, J. W. New Facts relating to Eozoon canadense. <*Proc. Am. Assoc. Adv. Sci.*, vol. xxv, pp. 231–234. 1876.

The fossil nature of *Eozoon canadense* is advocated. (White in White and Nicholson's Bib. p. 22.)

DAWSON, J. W. Eozoon canadense according to Hahn. <*Ann. Mag. Nat. Hist.*, ser. 4, vol. xviii, pp. 29–38. 1877.

A critical notice of a memoir by Hahn (see post.) in which the latter endeavors to show that *Eozoon* is a purely mineral structure. (Nicholson in White and Nicholson's Bib. p. 96.)

DAWSON, J. W. New Facts relating to Eozoon canadense. <*Canad. Nat.* new ser., vol. viii, pp. 282–285. 1878.

DAWSON, J. W. On the Microscopic Structure of Stromatoporidæ, and on Palæozoic Fossils mineralized with Silicates, in illustration of Eozoon. <*Quart. Jour. Geol. Soc. Lond.* vol. xxxv, pp. 48–66. 3 plates. 1879.

DAWSON, J. W. Note on recent Controversies respecting Eozoon canadense. <*Can. Nat.*, vol. ix; p. 228. 1879.

DAWSON, J. W. Mœbius on Eozoon canadense. <*Amer. Jour. Sci.*, vol. xvii, p. 196, wood cuts. 1879.

DAWSON, J. W. Notes on Eozoon canadense. <*The Can. Rec. of Sci.*, vol. i, pp 58, 59. 1884.

Abstract of a paper read before the British Association at Southport, 1883.

DAWSON, J. W. On the Geological Relations and Mode of Preservation of Eozoon canadense. <*Report Brit. Assoc.* (Southport, 1883), p. 494. 1884.

DAWSON, J. W. Canadian and Scottish Geology. An Address delivered before the Edinburgh Geological Society at the close of the Session, 1884. <*Trans. Edin. Geol. Soc.*, vol. v, pp. 113, 114. 1885.

Remarks on Eozoon canadense.

EDWARDS, A. M. Microscopical Examination of Two Minerals.* <*Proc. Lyceum Nat. Hist.*, pp. 96–98. 1870.

[*Supposed to be Eozoon.]

FRITSCH, A Ueber das Vorkommen des Eozoon im nordlichen Bohmen. *Neues Jahrb. fur Min.*, etc., pp. 352–354. 1866.

FRITSCH, A. Ueber Eozoon bohemicum aus dem Kornigen Kalke von Raspenau in Bohmen. <*Landesdurchforschung von Bohmen*,—Geol. Sect., pp. 245-251, 1 wood cut and 2 plates. 1869.

Not seen.

FRIC, ANTON (Dr.) Ueber Eozoon bohemicum, Fr., aus den Kornigen Kalkstein von Raspenau bei Friedland in Bohmen. <*Geologie von Bohmen* vol. i, pp. 245-256, 1 wood cut, 2 plates. 1869.

GUMBEL, C. W. Ueber das Vorkommen von Eozoon in dem ostbayerischen Urgebirge. <*Sitzungsber d. k. b. Akad. Wiss. Munch.* 1866, Bd. i, pp. 25–144, 3 plates.

GUMBEL, C. W. Eozoon im ostbayer. Urgebirge. <*N. Jahrb. fur Min. etc.*, 1866. I. S. 1 und *N. Jahrb. fur Min., etc.* 1866. S. 210.

GUMBEL, C. W. Eozoon im Urkalke von Sachsen. <*N. Jahrb. fur Min., etc.* 1866. S. 579.

GUMBEL., On the Occurrence of Eozoon in the Primary Rocks of Eastern Bavaria. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxii, pp. 23, 24. 1866.

A review by H. M. J.

GUMBEL, C. W. On the Laurentian Rocks of Bavaria. <*Cand. Nat.* new series, vol. iii, pp. 81–101, 1 plate. 1868 Translated from the proceedings of the Royal Bavarian Academy for 1886, by Prof. Markgraf.

[*EDITOR'S NOTE.—In revising and preparing this for the press, the original paper has been considerably abridged by the omission of portions, whose place is indicated in the text. Some explanatory notes have also been added.—T. S. H.]

GUMBEL, C. W. Eozoon im Kornigen Kalke Schwedens. <*Leonhard und Geinitz neues Jahrbuch.* 1869. pp. 551–559. 1869.

GUMBEL, C. W. Ueber die Natur von Eozoon. 8 p. Ratisbonne. 1876.

Not seen; title taken from a catalogue.

HAHN, DR. O. Giebt es ein Eozoon canadense? Eine mikrogeologische Untersuchung. < *Wurttembergische naturwiss.* Jahreshefte, 32 Jahr, pp. 132–155. (Translated by W. S. Dallas, Ann. and Mag. Nat Hist , ser. 4, vol. xvii, pp. 265, 282) 1876.

After an examination of serpentinous limestones from Canada and Europe, the author concludes that *Eozoon canadense* is of organic origin. (Nicholson in White and Nicholson's Bib. p. 108.)

HAHN, DR. O. Giebt es ein Eozoon canadense? Eine mikrogeologische Untersuchung. < *Wurtt. naturwiss.* Jahresheften, 1876, 24 pp. Stuttgart, 1876.

Printed as a separate pamphlet.

HAHN, (DR.) O. Giebt es ein Eozoon canadense? Erwide rungauf Dr. C. W. Gumbel's und Dr. Carpenter's Entgegnung. < *Wurtt. naturwiss* Jahresheften. Jahrgang. 1878. 21 pp. 1 plate. Stuttgart. 1878.

HAHN, O., in Reutlingen sprach uber das Eophyllum canadense aus dem Serpentinkalk des Laurentiangneisses von Canadas. < *Wurttemb. naturwiss.* Jahresheften. Jahrgang, 1880. pp. 71–74.

HAHN, O. Die Meteorite (chondrite) und ihre Organismen, 56 pp. 32 plates. 1880.

Plate xxx., fig. 5, Eozoon canadense, reputed canal system of Eozoon; fig. 6 the same. Both stones from which the slides were taken were collected by me in Little Nation. Let one compare the canal system of the nummulite fig. 3 with this reputed canal system! Figs. 3 and 5 should be the same thing.

HALL, J. Note upon the Geological position of the Serpentine Limestone of Northern New York, and an inquiry regarding the relations of this Limestone to Eozoon Limestones of Canada. <*Amer. Journ. Sci.*, vol xii, 3d ser., pp. 298–300, 1876.

Abstract of the paper read before the Amer. Association at Buffalo.

HAUER, M. Das Eozoon canadense. Eine micro-geologische Studis, mit 18 photographic plates. Leipzig. 1885.

HITCHCOCK, C. H. The Earlier Forms of Life (Eozoon). 16 pp. 10 figs. N. P. N. D.

HOCHSTETTER, —. Eozoon in Austria. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxii, p. 16. 1866.

HOCHSTETTER, R. F. Ueber das Vorkommen von Eozoon in Krystallinischen Kalke von Krumman in sudlichen Bohmen. <*Sitz. d. k. Akad. d. Wiss.*, vol liii, pp. 14–25. 1866.

HOCHSTETTER, (Prof V.) DR. W. B, CARPENTER IN LONDON. *Neuer Fund von* Eozoon canadense. <*K. K. geol. Reich. Ver.* 1868, pp. 69, 70. 1868.

HOFFMANN, R. On the Mineralogy of Eozoon canadense. <*Amer. Journ. Sci*, vol. i, 3d ser., pp. 378, 379. 1871.

HUNT, T. S. Laurentian Rhizopods of Canada. (Extract of a letter from T. Sterry Hunt, F. R. S., to J. D. Dana, April 2, 1864.) <*Amer. Journ. Sci.*, vol., xxxvii, 2d ser., p. 431. 1864.

HUNT, T. S. On the Mineralogy of Eozoon canadense. <*Canad. Nat.*, n. s., vol. ii, pp. 120–127, 1 plate. 1865.

HUNT, T. S. On the Mineralogy of certain Organic Remains from the Laurentian Rocks of Canada. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxi, pp. 67–71. 1865.

Gives a detailed account accompanied with analysis, of the mineral nature and structure of *Eozoon Canadense*. (Nicholson in White and Nicholson's Bib. p. 107.)

HUNT, T. S. Geology and mineralogy of the Laurentian Limestones. <*Geological Survey of Canada.* Report of progress from 1863 to 1866, pp. 181–233. Ottawa, 1866.

Though essentially mineralogical, this report contains many interesting observations bearing on the nature and mode of preservation of *Eozoon canadense*. (Nicholson in White and Nicholson's Bib. p. 107.)

HUNT, T. S. The Geological History of Serpentines, including Notes on pre-Cambrian Rocks. <*Trans. Roy. Soc.* Canada, vol. i, pp. 165–215. 1883.

JONES, T. R. Eozoon canadense in this country. <*Nat Hist. Rev. Lond.*, vol. v., pp. 297, 298. 1865.

In this communication to the editor he states that Eozoon canadense is abundant in the British Isles. Mr. W. A. Sanford has hunted it up in the Green Connemara marble, and he also finds it there in masses indicated by him. The best way of getting a sight of the structure due to the presence of Foraminifera is to dissolve small flakes of the "Irish Green" in very weak dilute acid, and then the shelly part being removed, the green silicates remain representing the sarcode that filled the chambers, pseudopodian tubules and stolon passages.

JONES, T. R. On the Oldest Known Fossil, Eozoon canadense. <*Popular Sci. Rev.*, vol. iv., pp. 343, pl. xv. 1865.

Discusses the geological and zoological relations of *Eozoon*.

JONES, T. R. On the Oldest Known Fossil, Eozoon canadense of the Laurentian Rocks of Canada; its place, structure and significance. <*Popular Sci. Review*, 1867, pp. 343–352, plates xv and 2 wood cuts.

A semi-popular account of *Eozoon canadense*. (Nicholson in White and Nicholson's Bib. p. 109.)

JULIEN, A. A. A study of "Eozoon Canadense." Field observations. <*Proc. Amer. Asso. Adv. Sci.*, vol. xxxiii, 1884, pp. 415, 416. (Abstract.) 1885.

KING, W. Note on Eozoon canadense. <*Nature*, vol. iv, p. 85. 1871.

KING, W., and T. H. Rowney. On the so called "Eozoonal Rock." <*Quart. Journ. Geol. Soc. Lond.*, vol. xxii, pp. 185–218, 2 plates. 1866.

The authors describe in this memoir the results of a careful chemical and microscopical examination of the Grenville "*Eozoonal*" Ophite, from which they arrive at the conclusion that Eozoon canadense is of truly inorganic origin. (Nicholson in White and Nicholson's Bib. p. 110.

KING W., and T. H. ROWNEY. On the so-called "Eozoonal" Rock. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxv, pp. 116, 117. (Abstract.) 1869.

The authors adduce further evidence that their views as to the mineral nature of Eozoon are correct (Nicholson in White and Nicholson's Bib. p. 110.)

KING, W., and T. H. ROWNEY. On Eozoon canadense. <*Proc. Roy. Irish Acad.*, vol. x, p. 506, 2 plates xli—xliv. 1870.

KING, W., and T. H ROWNEY. On the Mineral Origin of the so-called "Eozoon canadense." <*Proc. Roy. Irish Acad.*, ser. 2, vol. 1, pp. 140–153. 1871.

A reply to papers by Drs. J. W. Dawson and T. Sterry Hunt on the zoological and chemical aspects of the question respectively. The paper concludes with a recapitulation of the various points detailed in the formerly published papers of the authors. (Nicholson in White and Nicholson's Bib. p. 110.)

KING, W., and T. H. ROWNEY. Eozoon, examined principally from a Foraminiferal standpoint. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xiv, pp. 274–289, plate xix. 1874.

A controversial paper, in which evidence is brought forward to show that *Eozoon canadense* is inorganic in its nature. (Nicholson in White and Nicholson's Bib. p. 111.)

KING, W., and T. H. ROWNEY. Remarks on the subject of Eozoon. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xiii, pp. 390–396. 1874.

A summary of the chief points in favor of the mineral nature of *Eozoon canadense*. (Nicholson in White and Nicholson's Bib. p. 111.)

KING, W., and T. H. ROWNEY. Remarks on the "Dawn of Life" by Dr. Dawson; to which is added a supplementary note. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xvii, pp. 360–377. 1876.

A critical memoir, stating the objections held by the authors as to the supposed organic origin of Eozoon. (Nicholson in White and Nicholson's Bib. p. 111.)

LAUBE, G. Notizer von einer Reise in Scandinavien. <*Lotos*, xxiv, Jahrg. (Eozoon p. 21.) Prague. 1874.

LEA, I. Contributions to Geology. Philadelphia, 1833.

LEIDY, J. Remarks on Eozoon. <*Proc. Acad. Nat. Sci.*, 1877, p. 20. 1877.

LOGAN, W. E. Supposed Fossils in the Laurentian Limestone. <*Geology of Canada* pp. 48, 49, 2 wood cuts. 1863.

LOGAN, W. E. On Organic Remains in the Laurentian Rocks of Canada; (from a letter to the editors of this Journal from Sir W. E. Logan, F. R. S, dated Montreal, Feb. 17th, 1864.) <*Amer. Journ. Sci.*, vol. xxxvii, 2d ser., pp. 272, 273. 1864.

LOGAN, W. E. On the Occurrence of Organic Remains in the Laurentian Rocks of Canada. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxi, pp. 45–50. 1865.

This memoir is a geological one, occupied with a general description of the Laurentian Rocks of Canada, illustrated by sections. The author, however, gives an account of the discovery of *Eozoon* in the Lower Laurentian Limestone, and describes the general mode of occurrence of, and the appearance presented by, the specimens. (Nicholson in White and Nicholson's Bib. p. 112.)

LOGAN, W. E. On the Occurrence of Organic Remains in the Laurentian Rocks of Canada. <*Canad. Nat.*, new ser., vol. ii, pp. 92–99. 1865.

A reprint from the Quart. Journ. Geol. Soc. Lond., 1865, with some additional notes. (Nicholson in White and Nicholson's Bib. p. 112.)

LOGAN, W. E. On New specimens of Eozoon. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxiii, pp. 253–257. 1867.

This is a geological memoir, it is of interest to the palæontologist as giving a detailed account of the precise geological position of the bed from which was obtained the least altered example of *Eozoon canadense* (the "Tudor specimen") as yet known to science. (Nicholson in White and Nicholson's Bib. p. 113.)

LOGAN, W. E., J. W. Dawson, and T. S. Hunt. On the Occurrence of Organic Remains in the Laurentian Rocks of Canada. <*Report Brit. Assoc.* (Bath Meeting), Trans. Sections, p. 225. 1864.

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MOEBIUS, DR. K. Ist das Eozoon ein versteinerter Wurzelfussler oder ein Mineralgemenge? <*Die. Natur.* Jahrg. 1879, Nos. 7, 8, 10-21, wood cuts. 1879.

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NICHOLSON, H. A., and DR. J. MURIE. On the Minute Structure of *Stromatopora* and its Allies. <*Journ. Linn. Soc.*, vol. xiv, pp. 187-246, 5 wood cuts and 5 plates. 1878.

PARKER, JONES, and BRADY. On the Priority in the Discovery of the Canal System in Foraminifera. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol. xiv, p. 64, 305. 1874.

PERRY, J. B. Eozoon Limestone of Eastern Massachusetts. <*Amer. Nat.*, vov. v, pp. 539, 541. 1871.

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PART IV.

FRANCE AND ITALY.

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PART V.

AUSTRO-HUNGARY, BELGIUM, DENMARK, FINLAND, GERMANY, HOLLAND, NETHERLANDS, NORWAY, SWEDEN AND SWITZERLAND.

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PART VI.

RUSSIA AND TURKEY.

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ERRATA.

Page 177, line 10 from top—before word proper insert the.
Page 178, line 3 from top—for xxv read xv.
Page 178, line 4 from bottom—for Rocks read Limestones.
Page 179, line 15 from top—for xi read xl.
Page 179, line 16 from top—for This read The.
Page 180, line 20 from top—for S. W. read J. W.
Page 181, line 23 from top—for appearance read appearances.
Page 181, line 1 from bottom—for 66 read 68.
Page 182, line 8 from bottom—for 1886 read 1868.
Page 183, line 8 from bottom—for organic read inorganic.
Page 185, line 22 from top—for Notizer read Notizen.
Page 190, line 5 from bottom—for J. B. read J. W.
Page 191, line 4 from top—for 1871 read 1875.
Page 191, line 5 from top—for 1872 read 1876.
Page 191, line 6 from top—for Englypha read Euglypha.
Page 191, line 10 from top—for *Pascedlas* read *Pasceolus*.
Page 191, line 16 from top—for viii read vii.
Page 191, line 26 from top—for *Valulina* read *Valvulina*.
Page 191, line 27 from top—for *deceurrens* read *decurrens*.
Page 191, line 28 from top—for *plicatæ* read *plicata*.
Page 191, line 30 from top—for *Rotælia* read *Rotalia*.
Page 192, line 9 from top—for *Mantelii* read *Mantelli*.
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Page 193, line 18 from top—for Tadaissac read Tadoussac.
Page 193, line 12 from bottom—for Meridinale read Meridionale.
Page 194, line 10 from bottom—for Krede read Kreide.
Page 194, lines 12, 13 from top—for*polythalmia* read *polythalamia*.
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Page 196, line 14 from top—for *Lepidoiites* read *Lepidolites*.
Page 197, line 6 from top—for Om read On.
Page 197, line 1 from bottom—for Carribean read Caribbean.
Page 198, line 10 from top—for South read Southern.
Page 198, line 8 from bottom—for Foraminifera read Foraminiferen.
Page 200, line 2 from top—for Murry read Murray.
Page 201, line 14 from top—for Palaontologre read Palaontologie. Analysister read Analysirter.
Page 204, line 17 from top—for tublos read tubulosa.
Page 206, line 3 from bottom—for vii read iv.
Page 208, line 23 from top—for vii read viii.
Page 210, line 19 from top—for Polders read Polytremata.
Page 211, line 2 from top—for Roy read Ray.
Page 212, line 24 from top—for Polythemata read Polytremata.
Page 212, line 1 from bottom—for v read iii.
Page 213, line 13 from bottom—for 1882 read 1883.
Page 214, line 4 from bottom—for House read Howse. Kirkly read Kirkby.
Page 216, line 1 from top—for Prestwick's read Prestwich's.
Page 217, line 10 from top—for Mendon read Mendon.
Page 217, line 8 from bottom—for Tumanowiczie read Tumanowiczii.

Page 218, line 10 rom top—for Kirkly read Kirkby.
Page 218, line 2 from bottom—insert pp 264-266, 1 plate. For xxi read xx.
Page 219, line 11 from bottom—for Southerndoun read Southerndown.
Page 219, line 15 from bottom—for S R read St.
Page 219, line 1 from bottom—for xvi read xxvi.
Page 220, line 8 from top—for Britanica read Britannica.
Page 220, line 9 from top—for xl read xi.
Page 221, line 6 from top—for Protozon read Protozoa.
Page 222, line 5 from top—for xl read xi.
Page 222, line 6 from bottom—insert xiv.
Page 224, line 6 from top—for Snyopsis read Synopsis.
Page 224, line 19 from bottom—for 297 read 292.
Page 224, line 13 from bottom—insert Park.
Page 224, line 11 from bottom—for D read Dr.

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GENERAL INDEX.

VII.

NEW SPECIES OF FOSSILS.

BY N. H. WINCHELL.

CRYPTOZOON MINNESÓTENSE, n. sp.

Plates I and II.

(Compare *Cryptozoon proliferum*, Hall, thirty-sixth regents' report on the New York State Cabinet, plate VI.)

In 1875, and again in 1877 specimens of doubtful organic forms were collected by the writer at Northfield from the magnesian limestone beds that outcrop along the left bank of the Cannon river a mile and a mile and a half below the city. These were registered in the General Museum of the University with the numbers 2391, and 2563 without special description. In May, 1885, the same form was seen more abundantly in the uppermost layers of similar limestone at Cannon Falls, in Goodhue county, and was registered as a "supposed stromatopora," with the number 5865. In both cases this fossil has been found in the upper layers of this limestone, directly beneath the St. Peter sandstone, which can be seen in both places, in outcrop but a few rods away. The museum is indebted to Mr. W. H. Scofield of Cannon Falls, for the finest and largest perfect specimen of this fossil that has yet been seen. A specimen having the same laminated structure and from the same formation (so far as could be judged from the lithology and the geographical position) was found in the drift in Fillmore county; and silicified masses of laminated rock are referred to in the report on that county in vol. i of the final report, p. 283, where they are compared to *Eozoon canadense*. It is highly probable that all these belong to the same generic form, and probably to the same species, though there is a constant difference in outer

shape between those seen at Northfield and those at Cannon Falls.

The specimens obtained at Northfield (Pl. II., fig. 4) are sub-cylindrical with a conical upward apex. They are from one to three inches long, the length depending apparently on the circumstances that attended their removal from the enclosing rock, and from one to two inches in diameter. They appear, outwardly, like a succession of cups, or thimbles, piled on each other, the lower end of each covering the upper, closed end of the one below it. But the lower edge of each cup is ragged and capriciously fractured, due to the weathering out of the specimen from the enclosing rock, for it is probable that the specimens would not be discovered except for the distinctness of the cup-shaped lamination which is made conspicuous by exposure to the weather. It is evident that they are not always cylindrical, nor sub-cylindrical, since the impressions of the apices of several, remaining on the under surface of a small slab of rock, are somewhat elongated, though the most of these are concave, and shaped like the conical tops of the most of the detached specimens. The frayed edges of the laminæ vary in frequency and in thickness. Generally two or three occupy the space of a quarter of an inch, but the intimate structure shows, in a thin section, a much finer lamination, viz.: from six to ten laminæ in a quarter of an inch.

The specimens from Cannon Falls show a similar but much finer lamination, the laminæ being as frequent as six or eight laminæ in a quarter of an inch, as visible to the eye. In a thin section the fine lines indicating the sections of the laminæ are as numerous as ten to fourteen in a quarter of an inch (Pl. II, Fig. 3). Furthermore the Cannon Falls specimens are quite different in outward form. They are shaped like the fossil from the Trenton which is well known under the name *Chætetes petropolitanus*, but attain an immense size. The largest perfect specimen seen, detached, is that kindly furnished by Mr. Scofield, who found it at Cannon Falls, weathered out from the Shakopee limestone, and is nearly sixteen inches in diameter across the base, and eight inches in hight. Its form is well represented by figure 42 (A),* on page 317 of Mr. Nicholson's *Palaeozoic*

*Now separated by Mr. Nicholson under the name *Monticulipora (Diplotrypa) Whiteavesii*.

tabulate corals. Numerous others of equally symmetrical outlines, varying in size from three inches to ten inches in transverse diameter have been gathered at Cannon Falls. They are also seen to overlap each other and to be of various shapes when crowded in the rock. The surface of the rock is nearly covered with them over a space of a square yard or more at a point in the highway near the depot of the Chicago, Milwaukee and St. Paul railway. The under surfaces of perfect specimens are concentrically striated or ridged. This form has been seen at Mankato where it occurs in the upper portion of the bluffs, in the limestone that is used for quicklime, the diminished representative of the Shakopee limestone. It is more common than that seen at Northfield, and the name *minnesotense* is applied to it. The resemblance of the Northfield form to the Phrygian cap suggests for this variety the distinctive term *libertatis.*

These forms may be varieties of Prof. Hall's species *proliferum;* but they differ markedly from that in the manner of growth. They are convex upwardly, instead of concave, and while having apparently a main central point of attachment from which growth proceeded, they spread laterally over the surface, and each grand added layer of growth seems to be expressed in the concentric undulations seen on the base, which has a central depression rising toward the center of the mass.

Prof. Hall has kindly supplied me with a specimen and a mounted thin section of *Cryptozoon proliferum*, for comparison, from which it is seen that the lamination is quite similar in general character, but much finer in the Minnesota forms.

Locality and formation: Cannon Falls, Northfield, and Mankato in the Shakopee limestone.

Museum Register numbers 2391, 2563, 5865, and 6487.

RHYNCHONELLA AINSLIEI, n. sp.

Plate II, figs. 5 and 6.

Of this species only the exterior is known. It varies from a quarter of an inch, or less, to three quarters of an inch in transverse dimension. Mature specimens measure somewhat more than half an inch from front to rear. The plications are finer and more numerous than in *R. capax*, with which it is constantly

associated, but from which it can easily be distinguished by this obvious character. It is also a broader shell, generally, and, like *R. Capax,* has not been known to acquire in Minnesota those rotund proportions which the latter exhibits in Indiana and Ohio.

The smaller, or dorsal, valve has an upward, rounded flexure at the center which extends from the front about three-fourths of the distance to the beak, where it blends with the general convex surface of the valve. The corresponding flat depression of the ventral valve can be traced perhaps a little further toward the beak. On the dorsal valve are from 28 to 34 plications, of which six or seven are on the mesial fold. On the ventral valve, which has a distinct, free, perforate, curved beak, are about the same number of plications, of which six or seven are in the depressed mesial lobe. On each valve, the outer ones of those plications embraced in the mesial fold are partly on the sloping surface from the fold to the general surface of the valve. The mesial flexure of the valves is much less marked in the young specimens.

The beak of the dorsal valve is wholly hid by the curvature of the beak of the ventral valve. The beak of the ventral valve is perforated at the apex by a circular foramen which, however, is coalescent with the deltidium, which extends to the hinge-line with slightly diverging lateral margins. On either side of the deltidium of the ventral valve is a curving faintly striated lamella, simulating a cardinal area such as is seen in Orthis.

The plications of the shell are crossed diagonally by fine striations of growth, but in no case have these striations been seen so conspicuous and ornamental as in some specimens of *R. capax* from Ohio. Indeed they are hardly visible except under a magnifier.

Locality: This fossil is found throughout the southeastern part of the State wherever the Trenton shales appear in outcrop, and extends as far north as Minneapolis where it is common in the shales that overlie the Trenton limestone.

Museum numbers 324, 734, 4031, 5480, 5489, 5521, 5492, 5512, 5505, 5517.

The specific name is given in honor of Mr. N. S. Ainslie, of Rochester, Minn., at the request of Prof. R. P. Whitfield.

ORTHIS REMNICHA, n. sp.

Plate II, fig. 7.

Shell about an inch in transverse diameter and about three-quarters of an inch in length, from front to rear; it is regularly oblong-oval, with the greater diameter transverse, marked by coarse, bifurcating costæ which radiate from the beak. The ventral valve has a shallow mesial depression which begins near the beak and widens toward the front so as to occupy on the front margin nearly a third of the width of the shell. The beak is not prominent, and in all the specimens seen, which are rather poor, it seems not to rise beyond the hinge area; the cardinal angles are rounded, so far as preserved in any specimens seen.

Nó other characters of this shell can be given, as it is only seen in fragments which are but rarely large enough to satisfactorily characterize the genus *Orthis*. Very many impressions and fragments of its valves are found in a brownish magnesian limestone at Red Wing, which lies beneath the surface of the grade of the street, from two to six feet, at the corner of Brush and Main streets. This limestone was excavated in the construction of the city sewers, and seems to be a lenticular layer but a foot or two in thickness.

Formation: This layer is in the St. Croix formation, about 125 or 150 feet below the limestone which there rises in the summits of the bluffs.

Museum Register numbers 6041 and 6070.

Before this the only mention of Orthis at this low horizon seems to be that of Prof. A. Winchell, who has described *Orthis barabuensis** from Devil's lake, Wisconsin. (*Am. Jour. Sci.*, vol. xxxvi, p. 229. 1864); *Orthis pepina*, described by Prof. James Hall in 1863, (Sixteenth Report on the New York State Cabinet, p. 134,) who reported it from Reed's Landing, Minnesota, and Osceola, Wisconsin; *Orthis coloradoensis*, described by B. F. Shumard from Burnet county, Texas, (Trans. St. Louis Acad., vol. 1, p. 627), who incidentally (*loc. cit.*) referred to an Orthis "from the Potsdam sandstone of Minnesota," found in casts in a fine-grained sandstone, but which he never described, and *Orthis*

*Prof. R. P. Whitfield (Geol. of Wis., vol. iv, p. 171,) regards this as more likely to be a *Leptæna*

eurekensis, recently published by C. D. Walcott, from the Eureka district of Nevada. (Palæontology of the Eureka District, p. 22). The species described above differs widely from all these, and cannot be mistaken for either of them.

ORTHIS SANDBERGI, n. sp.

Plate II, Figs. 8 and 9.

Associated with the last are distinct impressions of a four-lobed brachiopod which is doubtfully referred to the genus *Orthis*. The greatest width of the shell is on the hinge-line, amounting to half an inch or somewhat less; from the ends of which the margins of the valves retreat abruptly, producing acute cardinal angles. After a shallow re-entrant angle, or curve, the lateral margins swell out again in passing the anterolateral spaces, forming rounded lobes, one on each side of the median line. As they approach the center of the front, they again crowd inward forming at the front an indentation. These lobes on the larger valve are coincident with elevations on the exterior of the shell, and the retreating angles with depressions, both of which extend from the margin to the beak, the aspect in general being rather spiriferoid or four-lobed. The specimens are all casts or impressions, the shell substance having been absorbed. These impressions are smooth, though there is in one case an appearance as if the outer surface of the large valve were marked by radiating costæ. The beak is apparently inconspicuous.

Formation and locality: Same as the last.

Museum register number 6490.

The name is given to this species in honor of Dr. J. H. Sandberg, of Red Wing, who called attention to this inconspicuous fossiliferous bed. Associated with this and the last, are occasional traces of what appear to be crinoidal remains, in the form of sections of the stems, about an eighth of an inch in diameter.

VIII.

A SUPPOSED NATURAL ALLOY OF COPPER AND SILVER FROM THE NORTH SHORE OF LAKE SUPERIOR.

By N. H. WINCHELL.

In the course of preparation of the exhibit of the Minnesota department of geology, fauna and flora, at the late exposition at New Orleans, I obtained at Duluth a mass of native copper, similar to numerous others that have been found in the drift-deposits in the northwest. This was loaned for the use of the exposition, and was exhibited during its continuance. It is owned by Hon. G. C. Greenwood of Duluth, and is said to have been found near the mouth of Temperance river, in Minnesota.

This piece of copper had been assayed to ascertain its content of silver, which was evidently present throughout the most of the specimen. Several holes had been drilled through it for the purpose of getting a fair average by the use of the drillings, and the prevalent opinion of the amount of the silver was stated, from recollection, to be five pounds of silver and three pounds of copper, and it was thus labeled, while on exhibition at New Orleans, the official statement of the assayer having been lost.

On the return of this specimen from New Orleans I was struck with the appearance which it presents. The two metals are plainly, but not homogeneously, alloyed. It has been stated that these two metals are never thus found alloyed, though in immediate contact, in the copper-bearing rocks of Lake Superior.

Dr. C. T. Jackson, who was the first to call public attention to this point, so far as I have been able to ascertain, stated in 1849,*

*Report on the geological and mineralogical survey of the mineral lands of the United States, in the State of Michigan, 1849, pp. 386, 461.

"that only one other locality is known in the United States of a mixture of native copper and silver, and that is in Somerville, N. J." He saw a mass of native copper taken from the old Bridgewater mines which had numerous lumps of silver projecting from its surface, though firmly united to the copper at the point of contact. He calls attention to a "series of facts altogether new in practical geology, viz., the occurrence of veins of solid metalic copper, admixed with native silver and not alloyed with it." He affirms that he has "analyzed hundreds of specimens without ever finding any true alloy of the copper and silver. In cases where it was first supposed to have been an alloy, it was subsequently found to be merely a mechanical mixture of the two metals. Had they no affinity for each other the particles could not have been more separate, but since we know that molten copper and silver readily and most quickly unite, forming an alloy when they are brought in contact, and know also that the copper requires a much higher temperature for its fusion, it is difficult to conceive that the metallic lode of the mine was deposited in a molten condition."

Messrs. Foster and Whitney in their report on the Lake Superior land district* in 1850, refer to the unalloyed condition of copper and silver in these rocks Though it had been asserted that some of the native copper contains a small portion of silver alloyed with it, they found no silver in the specimens which they examined unless particles of that metal were visible in the mass. A specimen of native silver from the Minnesota mine was found to contain a trace of copper; though in general, they stated these metals do not occur alloyed with each other, as would naturally be supposed on the theory that they have been forced up together in a state of fusion from the heated interior of the earth. "The silver is scattered through the metalic copper in such a manner that each metal remains entirely free from alloy with the other, although the junction of the two at their edges is a perfect one. The silver is often interspersed in the mass of copper so as to form a species of porphyry, the former metal occurring in small patches and particles perfectly soldered to the enclosing mass of copper, yet, chemically speaking, entirely distinct from it."

*Report on the "copper lands" of the Lake Superior land district in Michigan, 1850, p. 178.

Prof. R. Pumpelly never found these metals in the least alloyed together, though constantly occuring in intimate union.* *Dana's mineralogy* mentions no instance of silver and copper found naturally alloyed. Pumpelly states that the union between them is often so slight that on being rolled out into a sheet the silver becomes more or less separated and may be wholly detached.

Under these circumstances, when those who have carefully studied the metallurgy and paragenesis of these substances in their native places have not been able to find a single instance of a natural alloy, the conditions which can be seen plainly shown by this specimen are certainly a matter of surprise and of scientific interest. On asking Prof. Dodge, of the University of Minnesota, to make an assay of this specimen, he stated that he made the former assay, nearly two years ago, and he kindly gave me the following statement of the two trials which he made. He drilled six one-fourth inch holes through it, to obtain the drillings for each assay:

FIRST RESULT.

Copper	99.04 per cent.
Silver	.06 per cent.
Iron	traces.
Gold	none.

SECOND RESULT.

Copper	99.004
Silver	.096
Iron	traces.
Gold	none.

The average proportion of silver is less than one per cent, but it is evident that in some parts of the mass the silver is much more, and would perhaps reach from five to ten per cent. There are also some evidently nearly pure silver streaks or blotches, which are revealed by freshly abraiding the surface.

This mass having been found on the surface mingled with the drift pebbles, there is no certainty that it is natural. Indeed there are some outward signs, in the specimen itself, aside from

*Geological survey of Michigan, Vol. I, copper bearing rocks, pp. 110, 85.

the *a priori* improbability, that it may have been in the hands of the ancient miners who once wrought the copper-mines of Lake Superior, and that its present condition is due to their mining methods.

(1.) In the first place, it is in the form of a sheet from a fourth to a half an inch in thickness, of the shape nearly of an equilateral triangle.

(2.) It is coiled at one corner so that the corner nearly touches the opposite side, and has the appearance of having been forced into this shape.

(3.) If this were uncoiled, the straightened edge would form nearly a right line, about eight inches in length, a fact which is improbable with a piece of native copper in its original condition.

(4.) This edge, and also another edge for a distance of about two inches, has a roughly laminated, or sheeted structure, such as might have been produced by some pounding and crowding when in a semi-molten condition.

(5.) There is, all over the exterior, on one side of the specimen, a roughness of fine reticulated corrugations, alternating ridges and furrows, not long continuous, but broken, varying from a thirty-second part of an inch apart to an eighth of an inch, simulating a somewhat disturbed fluidal surface cooled. In some cases these little furrows enclose rounded, or somewhat polygonal spaces, as two or more systems seem to cross each other, resembling the shrinkage crack of drying clay, or the basaltic structure of the top of a lava flow.

(6.) On the other side, where there are some traces of malachite, this surface structure is almost wanting; but instead of it there is a coarse, but smoother, imprint of irregular forms that may have been due to the nature of the rock or other substance on which, as a molten mass, it may have lain.

When, in connection with these indications, it be remembered that the ancient miners, who were probably the ancestors of the present Indians, used to extract the copper from the rock by the aid of fire, it seems very reasonable to suppose that this piece had been thus affected, and that it had been dropped by them in their journey from Isle Royale to the southern or western tribes. Such pieces were seen in the hands of the Indians in the 16th

century, by Cartier and Champlain. One of the chiefs drew from a sack a piece of copper a foot long and gave it to Champlain. When he was more questioned as to its source, the chief answered that they had gathered it in lumps, and having melted it, spread it out in sheets, smoothing it with stones.*

This piece not only appears to confirm the report of Champlain as to the primitive methods of metallurgy of copper, but perhaps will throw some light on the so-called *hardening*, or tempering, of copper which has been attributed to the early miner. Mr. P. R. Hoy, of the Wisconsin Academy of Sciences, argues that the ancients did not melt their copper, nor cast the implements they made, but attributes to them the skill necessary for "swedging" hatchets, &c., in moulds, hardening their edges by hammering. It may be that a slight alloy of silver, taken so as to affect the edge of the implement, could be as readily made to harden it as the supposed pounding in the process of swedging.

Owing to doubts expressed by some archæologists as to the genuineness of this find, on the occasion of the reading of the foregoing paper at the Ann Arbor Meeting of the American Association for the Advancement of Science, in the Summer of 1885, the following sworn affidavits were obtained of parties who were concerned in handling it since its discovery, and of the person who found it:

STATE OF MINNESOTA, COUNTY OF ST. LOUIS.—SS.

L. Augustus Taylor, being duly sworn, deposes and says that he is a resident of Duluth, Minnesota, that he discovered an alloy specimen, now reported as the Greenwood specimen in the University of Minnesota Museum, as deponent is informed and believes, that he discovered the same in the year 1883 in the Temperance river in the bed of the stream about two miles from the mouth of the stream, and about one mile from the North Shore Silver and Copper Mine in Cook county, Minnesota. That this deponent gave the specimen to B. B. Spalding and is informed by the latter that he gave the same to George Greenwood and that no change of any kind was made in said specimen from the time this deponent obtained it until he delivered it to said Spalding.

L. A. TAYLOR.

*Voyage du Sieur de Champlain, Paris, 1613, p. 246.

Sworn to and subscribed before me this 1st day of October, 1885.

SHUBAD F. WHITE,
[Notarial Seal.] Notary Public,
St. Louis Co., Minn.

STATE OF MINNESOTA, COUNTY OF ST. LOUIS.—ss.

B. B. Spalding, being duly sworn, deposes and says that he received the specimen of alloy mentioned in the foregoing affidavit from L. Augustus Taylor who made said affidavit and delivered the same unchanged, except by the cutting off of a piece weighing about one-half pound, to George Greenwood of Duluth.

B. B. SPALDING.

Subscribed and sworn to before me this 1st day of October, 1885.

SHUBAD F. WHITE,
[Notarial Seal.] Notary Public,
St. Louis Co., Minn.

STATE OF MINNESOTA, COUNTY OF ST. LOUIS.—ss.

Geo. C. Greenwood, being duly sworn, deposes and says that he received the specimen referred to in the foregoing affidavits, from B. B. Spalding, the affiant in the last above affidavit, and delivered the same unchanged to Prof. N. H. Winchell of the University of Minnesota, and that the same was, when he last saw it in the University of Minnesota Museum, within a week past, in the same condition as when he delivered it to said Prof. Winchell, with the exception of a small hole since drilled in it.

G. C. GREENWOOD.

Subscribed and sworn to before me this 1st day of October, 1885.

SHUBAD F. WHITE,
[Notarial Seal.] Notary Public,
St. Louis Co., Minn.

IX.

REVISION OF THE STRATIGRAPHY OF THE CAMBRIAN IN MINNESOTA.

By N. H. WINCHELL.

In the ascent of the Minnesota valley for the purpose of geological examinations, in 1873, two different formations of limestone were met with, separated by a white sandstone. These were designated from the towns at which their characteristic outcrops occurred; the Shakopee limestone, the St. Lawrence limestone, and the Jordan sandstone. The thickness of neither one of these was known accurately, but the Shakopee limestone was said to be "about seventy feet," the Jordan sandstone "about seventy feet," and of the St. Lawrence limestone not more than fifteen feet could be affirmed.

In subsequent years as the survey progressed southeastwardly through Fillmore, Houston and Winona counties, these three parts were distinctly recognized, and this three-fold division was described at Lanesboro, Troy, Lewiston (near Stockton), and in western Wabasha county. In ascending the Mississippi valley in the progress of the survey, the intervening sandstone, as recognized in the southeastern part of the State, and the Shakopee limestone, gradually lose the development which they were seen to have in the southeastern part of the state, and the "Lower Magnesian" as defined by Dr. Owen, seems to become one great limestone stratum by the union of the two limestones through the omission of the Jordan sandstone. This omission, however, is not found to prevail everywhere even in the more northern counties, since in Goodhue and Washington counties this sandrock is plainly preserved, and has an observed thickness of five to ten feet, occurring in lenticular strata.

Again, about in the same proportion and rate of progress, as the sandstone separating the two limestones shrinks in thickness, another limestone is developed in the Mississippi bluffs at a considerably lower horizon, increasing toward the north and northwest. This change has been the cause of some mistaken identifications of stratigraphy by the survey, both in the Mississippi valley and in the Minnesota valley, and it is the intention of this revision to correct these, and to exhibit, briefly, the stratification of this portion of the Cambrian as it is developed in Minnesota, so far as the facts at hand will allow. For the purpose of adjusting some of the apparent discrepancies the writer recently made a cursory re-examination of those points in the Minnesota valley which were likely to throw light on the problem. The stratigraphic facts brought out by this re-examination are expressed below. Prior to this Mr. Upham had called attention to the great apparent thickness of the Shakopee limestone as developed by deep wells at Shakopee, which would make it parallelize with the chief limestone formation in the bluffs of the Mississippi at Hastings, instead of with the upper member which had been traced, under the name of Shakopee limestone, from Houston county to Hastings, and had shown by a study of the deep wells of the central part of the state that a calcareous member, comparable to the St. Lawrence limestone at St. Lawrence, exists below that which had been regarded its equivalent in the Mississippi bluffs.

With the facts all in mind, it was deemed best to make a special search, in the Minnesota valley, for the thin upper sandstone which had been found gradually thinning out toward the north, and that overlying upper limestone which had been identified since 1873, as the Shakopee limestone in the valley of the Mississippi, and to ascertain their actual relations to the Shakopee at Shakopee, and to the St. Lawrence at St. Lawrence. It is evident, whatever might be the result, that the extension of the strata there seen, and those only, would constitute the Shakopee and St. Lawrence limestones in their development further southeast and east.

This search was successful, but before the sandstone was actually found *in situ*, a fresh examination was made of the quarries at St. Lawrence. This was sufficient to show to any

one familiar with the lower-most of the limestones of the Mississippi valley, quarried at Lake City and at Hokah, that the actual St. Lawrence limestone must be parallelized with it and not with the great limestone member which forms the conspicuous escarpments of the great valley. This is evident not only from its lithology but also from its thickness, and from facts which were observed afterward at higher points in the Minnesota valley. This being established, it is evident that the sandstone which directly overlies it (the Jordan) must be the upper portion of the St. Croix in the Mississippi bluffs, having a thickness of nearly a hundred feet.

Having thus once determined the equivalents of the St. Lawrence and the Jordan, in the Mississippi valley, it also became evident that the regular order would require that the principal limestone in one place should parallelize with that of the other, and that hence the great limestone, as supposed to exist at Shakopee could be no other than the great stratum seen at Hastings.

The existence of the great thickness of this limestone at Shakopee rests on the uncertain testimony of the deep wells there which have penetrated it. But although the details of these wells are not obtainable so as to show the possible existence or non-existence in this limestone of any thin beds of sandrock, yet they unite with sufficient testimony to demonstrate that there is under Shakopee village, extending far below any rock exposed in the quarries, a stratum of limestone, or what the well-drillers denominate wholly limestone, that is entirely comparable to that in the bluffs at and near Hastings, and should be parallelized with it. The quarries at Shakopee involve only from 15 to 20 feet of the uppermost layers of this stratum, and to these layers the term *Shakopee* should be applied—and only to these, or, at most, to those underlying layers that extend downward to the thin sandstone which is known to exist, with more or less persistence, in this great formation, about 25 feet below its top (see reports on Fillmore, Houston, Winona, Wabasha, Olmsted, Goodhue, Dakota and Washington counties) and which has been supposed hitherto to represent the Jordan, but which is really another and distinct member of the Cambrian.

It was for the purpose of seeking for evidence of this thin

sandstone in the Minnesota valley that the recent examination was made. At Shakopee there is no direct evidence of this sandstone. All the evidence there is is that derived from the deep wells, which do not mention it; but it is well known that a thin stratum of sandstone, only five to ten feet thick, might be pierced by a drill, in sinking a deep well without the knowledge of the operator, the difference in the *chuck* of the drill, and the infrequency of pumping not being sufficient to detect it when the underlying and overlying strata were similar and somewhat arenaceous limestones.

However, at a short distance above Shakopee, at the Louisville limekilns, and between them and the river, before the appearance of the Jordan sandstone in the river, this limestone underlying the city of Shakopee is significantly divided into two parts, each part extending horizontally over considerable distances forming a marked terrace-flat. These parts exhibit different outward lithological aspects and intimate stratigraphic structure. The upper one is that which is wrought for quick lime at the limekilns at Louisville, and rises to the hight of 75–100 feet above the other. It is set off markedly from the other by a bluff which is composed largely of river-terrace gravel, and is so hid by this material that its existence is known only at a few places. It apparently exists as island-like remnants in this region, since it was not found in Mr. Jacob Thorn's well situated in section 15, Jackson, Scott Co., just east (a little north) of the quarries at Louisville, which went through gravel and sand 130 feet, blue clay 4 feet, and then entered a reddish limerock in which the drill was working at a depth of three feet at the time of this visit, and which is the equivalent of the lower reddish rock seen in the terrace that separates the limekilns from the river. The thickness of lime rock involved in this upper terrace of Louisville cannot be seen to exceed 30 feet, but it rises, apparently, about as high as the top of Mr. Thorn's well, and may exceed that thickness. The stone is very irregular in its bedding, and like the real Shakopee limestone, answering to the descriptions, given before, of the exposures at Shakopee, at (or near) Quincy, in Winona county, and at Northfield. The beds undulate, swell out, anastomose, become vesicular, then compact, change to shale which is green, are interbedded with shale, &c., &c., and do not resem-

ble at all the main body of limestone along the Mississippi bluffs. These rough upper beds swing back from the river in their line of strike, a little to the northeast of Merriam Junction, and are not known to occur in outcrops again, in their entirety, in the Minnesota valley. These are the beds which properly and correctly represent the Shakopee limestone, and they manifest their tendency to retreat from sight here, and further up the Minnesota valley, in the same manner as they have been seen to do in all places in the Mississippi valley. It is the lower limestone, that which forms the lower terrace at Louisville, which returns in force along the Minnesota valley above the rapids near Carver. The only evidence, at Louisville, of the existence of any intervening sandstone consists in the fact of the separation of this formation into two terrace-like expanses, one of which continues thence invisible, and the other extends as an independent formation as far as Mankato. The disintegrating action of a few feet of crumbling sandstone in an otherwise homogeneous limestone formation, along a great valley of erosion is a well known agent in causing the retreat of the upper portion, in its line of strike, farther away from the river. When the beds overlying the sandrock are themselves more irregular and likely to be carried away on the removal of the crumbling sandrock, the retreating habit of these upper layers is easily accounted for.

The limestone in the lower terrace, west from the Louisville kilns, is reddish, resembling the rock at Kasota, and rises about 45 feet above the flat on which the Minneapolis and St. Louis railroad passes from Carver, about a quarter of a mile distant, on its course to Merriam Junction. By reason of the dip this also soon passes off eastward, giving place to the Jordan sandstone, which is conspicuously exposed in many places. In regular order, the dip continuing in the same direction, the lower-most limestone appears at St. Lawrence, about four miles further west. At Belle Plaine, the salt well struck no limestone. The river runs over the St Croix, presumably, for several miles above Belle Plaine, the beds of which are so erosible that they do not make their appearance through the heavy drift-sheet which prevails generally in that part of the state. Not mentioning the conjectural exposure of rock in the bluff at Rocky Point, near Blakeley, which was not visited on the recent trip, the next

appearance of the limestones of the valley is on the west side, where, at Faxon, and again at points somewhat further south, in Jessenland, are outcrops of thin-bedded limerock, as recorded in the second annual report, which appertain, with great probability, to the horizon of the St. Lawrence limestone. There is no further outcrop, so far as known, before reaching Ottawa, where the beds that are the equivalent of the layers of the lower terrace at Louisville return and are wrought by numerous quarries. Considerable time was spent in examining these quarries, where may be found some remnants of the Cretaceous filling cavities in the older rock in the same manner as at Mankato. These quarries show all the characters of the stone quarried at Kasota. They are underlain by a white sandstone, which displays itself in the bluff to the thickness of 55 feet (including the talus) at the quarry of Mr. Schwartz, three-fourths of a mile below the station. This sandstone contains isolated patches and and also some thin leaves or laminations of green shale which fades to white. It was evidently deposited in an agitated water, as it contains sudden changes in the sedimentation-lines, even angular fragments of itself, one and two inches across, that are discordant with the enclosing sedimentation. It may be on the parallel with that conglomerate seen at the crossing of Van Oser's creek, near Louisville, in the upper part of the Jordan sandstone where, (recently) were seen some pebbles of red granite over an inch in diameter, and scales of ochery shale, or rusted soft rock, embraced in the white sandstone.

The limestone quarried at Ottawa lies in heavy but undulating layers, similar to those at Kasota, and furnishes a good building stone. These are near the bottom of the limestone to which they belong. The Shakopee beds probably exist in the eastern and southern (higher) portions of the Le Sueur prairie, which thus repeats the upper prairie at Louisville, while the flat on which Ottawa is situated owes its existence to the same cause as the lower terrace at Louisville.

After another interruption of five miles the same horizon returns at St. Peter, the beds having a fair exposure in the low river bluffs near the asylum. At the highway bridge at St. Peter there is no limestone preserved; the bluff on which the bridge rests at the west end consisting wholly of sandrock. On the top

of this sandrock is a thin deposit of reddish shale which amounts to about four feet, as it can be traced back from the river up a little ravine. Back from the river it is lighter colored. This is believed to be Cretaceous, though there is no evidence of it except its anamalous stratigraphic position. It may be a representative of the shale overlying the Jordan sandstone at the cement works at Mankato, though at no other point, north of the cement works, has such a shale been seen immediately overlying the Jordan—not even in the northern confines of Mankato. The limestone beds overlying this sandstone were not re-examined. Some information concerning them can be found in this report, at page 12, where the record of the hospital deep well is printed. It is probable that No. 3 of that record is the true St. Lawrence limestone, but that it was not wholly a magnesian limestone; also that the St. Peter rock, as quarried at the asylum, is the equivalent of the Kasota and Mankato quarries, and that, hence the true Shakopee beds will be found in the upper prairie level back of the asylum, into the composition and origin of which those beds enter with the same agency as at Louisville and at Ottawa. Indeed, the prevalence of large northern boulders on the hillsides and on the upper prairie flats back of St. Peter, points to the same cause as where they are strewn over the Shakopee terrace, between Shakopee and Louisville, and at other places that could be mentioned, where the immediate cause thereof is known to be the underlying firm beds of magnesian limestone. The sandstone seen at the old asylum quarry in 1873 (see the second annual report, p. 132), is also now regarded as Cretaceous. It has not been seen since 1873, but the sandstone of the lower Cretaceous is well known to cover all the Cambrian strata unconformably, in this part of the state, (see the report on Blue Earth county, vol. 1, final report), and traces of it are visible as far north as the quarries at Louisville, where pockets of white sand are found in the upper portion and are reported on the top of the quarried beds of the Shakopee. Similar patches of arenaceous Cretaceous are found at the asylum farm near St. Peter, and were fully identified as such in 1873. Second annual report, p. 177.*

*Capt. Beatty states that there is a large deposit of sandstone, more or less disintegrated, probably of Cretaceous age, in the bluffs east of the railroads at Mankato.

The river only intervenes between St. Peter and Kasota, and all the characters seen at the former place are repeated at the latter.

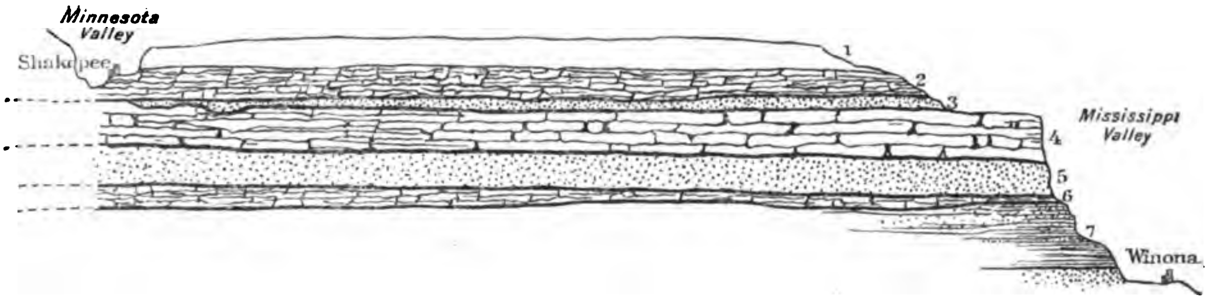
From Kasota to Mankato, a distance of six and a half miles, no great change is apparent. The St. Peter and Kasota terrace continues all the way to Mankato, and its uniform composition is manifested not only by the outward terrace-like aspect, but by several important quarries, and by exposures along the river bluff, intermediate. The difference between the limestone at Kasota and Mankato is one of difference of thickness. At Mankato the bluff contains an aggregate of about sixty feet of the limestone corresponding to the limestone of the lower terrace at Louisville, and at Kasota this limestone shows not more than twenty-one feet. In both cases they lie on the Jordan sandstone.

The most interesting observations respecting these limestones were made at Mankato. In the first place owing to the great thickness of the quarried beds, it was probable that the terrace north from the city was nearly on the level of the supposed thin sandstone stratum which had been presumed to exist between the true Shakopee limestone and the beds there quarried. Hence a careful search was instituted for traces of this sandrock. It was not long before angular or sub-angular masses of white arenaceous quartzyte were met with in traveling over the prairie north from Mankato, resembling the angular pieces that have been described at about the same horizon, weathered out from this sandstone in Winona and Houston counties. In several places were found bared spaces of this white hard sandrock, or quartzyte, forming the natural surface of the prairie, this being wholly above the beds quarried at the city. In several other places still further north, were found isolated low mounds of magnesian limestone rising three to six feet above the rest of the prairie, while about their flanks, near the level of the prairie, were bare areas of the same flat-lying, white, hardened sandrock, so situated as to show that it continued uninteruptedly beneath, and formed the base of the mounds. These mounds are therefore remnants of the true Shakopee limestone and this hardened white sandstone, here not more than four feet in thickness, and sometimes wanting entirely by reason of the surface destruction

due to the action of the river in early times, is the western extension of the thin sandstone which had been so often described in counties further east and styled Jordan. Still further north, and a little further from the river, the limekiln which was formerly owned by Geo. C. Clapp, sec. 17, Kasota, is probably based on the limestone overlying this sandstone, and hence on the true Shakopee. Further evidence of the parallelism of these upper beds with the true Shakopee consists in the fact that the fossil described in another part of this report, *Cryptozoon minnesotense,* is found in loose weathered fragments on the prairie on which these mounds occur, and it has before been found only in the Shakopee at Cannon Falls and at Northfield.

After the discovery of these facts, all the topography and geology of the Minnesota valley are in harmony with themselves, and with the same in the Mississippi valley. Some changes must be made in the designations applied to the limestones in both valleys, and new designations must be found for the two new strata thus added to the upper Cambrian. The following general diagrammatic section will express the comparative and correlative geology of these beds in the two great valleys:

Fig. 10.



EXPLANATION OF FIGURE 10.

1.	Drift and Trenton and St. Peter	
2.	Shakopee limestone	20—40 feet.
3.	White sandstone	0—40 feet.
4.	Magnesian limestone	75—175 feet.
5.	Jordan sandstone	75—100 feet.
6.	St. Lawrence limestone (shaly)	0—30 feet.
7.	Sands and Sandy shales	at least 200 feet.

Notes on the Foregoing Figure: The St. Croix formation includes all below No. 4, and extends down to the great sandstone which is struck in deep wells at Red Wing and Lake City, and appears at Hinckley and in the gorge of the Kettle river in Pine county. This lower great sandstone is more likely to be the Potsdam of New York state than the sandstone No. 5, or any part of this section.

No. 2 is the Shakopee limestone at Shakopee, as there exposed, and as described in the counties in the southeastern part of the State, in the reports of progress and in vol. 1 of the final report. It is the limestone burned for quicklime at Northfield and at Louisville. It is the same as the Willow river limestone, of L. C. Wooster. (Geol. Wis., vol. iv, p. 106).

No. 3 is a white sandstone which has not, till recently, been identified in the Minnesota valley, but it has been described, erroneously, as the Jordan sandstone in the southeastern part of the State. It was first described at Lanesboro, in 1875, under that name, but as the Jordan sandstone lies lower it is obviously necessary to find some other designation for this member. In the report of the Wisconsin Geological Survey for 1877, Mr. L. C. Wooster describes a similar white sandstone in the upper part of the lower Magnesian, near New Richmond, in Wisconsin, and remarks that this may represent the Jordan sandstone of Minnesota (as the Jordan had then been described in Fillmore and Houston counties), but he applied no designation. However, in the final report of the Wisconsin Survey, (vol. iv, pp. 106, 127), Mr. Wooster applies the term *New Richmond beds*, to this sandstone, and that term might be extended, being prior in its correct application, to this sandstone in Minnesota.

No. 4. This is the limestone which is generally known as the Lower Magnesian. It was supposed, till lately, to be the actual extension of the St. Lawrence limestone into the eastern part of the State, and has been so named in the reports of progress, and in vol. 1 of the final report. It has never received a distinguishing appellation—except that Prof. Irving has styled it the "Main body of limestone," (*Am. Jour. Sci.*, June, 1875, p. 440), though at Madison, where this term was applied, it is no more than 85 feet thick. It is the limestone which forms the lower terrace at Louisville, which is wrought at Ottawa, appears at St. Peter, and

extends conspicuously along the Minnesota river from Kasota to Mankato. Along the Mississippi it forms the precipitous escarpments at the tops of the bluffs.

No. 5. The Jordan sandstone is the upper most member of the St. Croix. The name Jordan was applied to this in 1873, in the annual report of that year. Prof. Irving has named it Madison sandstone in Wisconsin. (*Am. Jour. Sci.*, June, 1875, p. 440.) This sandstone has been correctly described throughout the Minnesota valley in all the reports of progress, but it was wrongly identified in the eastern part of the state.

No. 6. The St. Lawrence limestone was so named in the report of progress for 1873. It is the same that Prof. Irving named, in 1875, "Mendota limestone." This limestone is unfavorably exposed in the Minnesota valley. Its greatest thickness, known there, is only about 15 feet, but it seems to extend, with some shaly components, distinctly over a thickness of about 30 feet in the Mississippi valley; while, if the shaly beds with which it is associated, and into which it seems to graduate, be included under this term, it will include beds to the amount of nearly 200 feet. This is the chiefly fossiliferous portion of the St. Croix formation. It is found at Red Wing, to contain some new fossils, described in another part of this report. It is quarried at Lake City and contains *graptolites*, and at Hokah, where it affords *Dikellocephalus*.

No. 7. These shales and shaly sandstones graduate upward into the St. Lawrence limestone, as above mentioned. They are underlain by a gray micaceous sandstone which is known recently as the *Dresbach sandstone*, from a town in Winona county, where it is wrought for construction.

There are therefore, in Minnesota and Wisconsin, three magnesian limestones, and four saccharoidal sandstones, not including some shales and lower sandstones, involved in regular alternation in the Cambrian, thus—

St. Peter sandstone.
Shakopee limestone.
New Richmond beds.
Main body of limestone.

St. Croix.
Jordan sandstone. (Potsdam?)
St. Lawrence limestone.
Shales.
Dresbach sandrock. (Potsdam?)

Shales.
Hinckley sandrock. (Potsdam?)
Red shales and red sandrock passing into the Cupriferous? (Potsdam?)

X.

NOTES OF A TRIP UP THE THIEF RIVER AND AT LAKE MILLE LACS.

BY F. L. WASHBURN.

MINNEAPOLIS, NOV. 27, 1885.

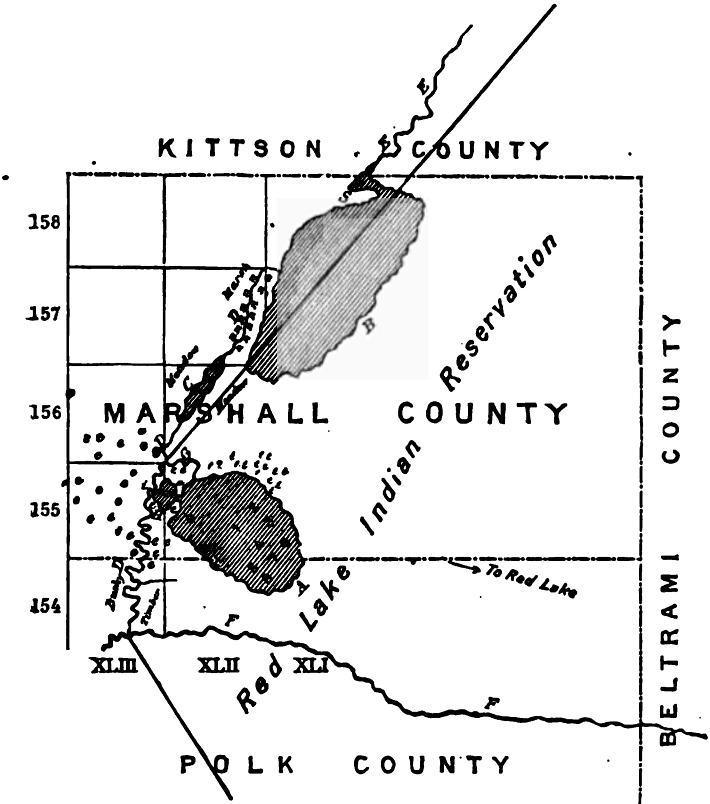
Prof. N. H. Winchell:

DEAR SIR.—At your request I send you the following account of the Thief River region and append thereto a map which may be somewhat of an auxiliary to my necessarily rather meagre description of the country.

Thief river forms part of the southwestern boundary of the *Red Lake Indian Reservation*, and has a general north and south direction. At the northeast corner of T. 43, R. 155, it is met by Mud river, a small stream, 10 yards wide, a mile and a half long and about 2½ feet deep, flowing from Mud lake and entering the Thief from the east. My northward progress, as you know, was stopped here and I was compelled, by bad weather and lack of time, to turn back. Beyond this point, to the north, the river is reported to be navigable for a canoe through Basil lake and as far as Thief lake. In other words, Thief river is navigable its entire length, from Thief lake to its mouth, on the Red Lake river.

Thief lake is a body of water about 14 miles long and 6 wide, a favorite resort for aquatic fowl. Its shores are reported more or less wooded with hard and soft timber and much of the shore lies in unsurveyed territory. At its very northern extremity, hidden behind the point S (Poplar Point), an opening is found which takes one into Moose river, flowing from the north, which

Map of Thief River Country.



Scale 12 miles to one inch.

Explanation of the Map.—A, Mud lake; B, Thief lake; C, Basil lake; DD, Thief river; EE, Moose river; "very crooked, sluggish and deep for 25 miles from its mouth." FF, Red Lake river; G, Mud river; about 10 yards wide, 2 feet deep and 2½ miles long, flowing from Mud lake to the Thief river. H, a muddy estuary of Mud lake, connected with it by a reed-grown passage containing a few small grassy islands and opening into Thief river by a narrow passage (i) just wide enough for two canoes to pass one another.

1, 2, 3, 4, 5, large islands in Mud lake, numbered in order of their relative size, No. 1 (the only one visited), containing about 1½ acres; all the larger islands apparently have timber upon them. 6, 7, 8, smaller islands; 9, a grassy knob or knoll, of which there seem to be many.

n n n n n, high banks along Thief river, just after leaving Thief lake, "covered with hard-wood timber." The narrow strip of land (marked p p) between the lake and the river is covered with oak, ash and elm.

S, Poplar Point.

t t t t t, tamarac, and back of it the ground rises a little. e e e e e, impassable marshy land, filled with reeds, rushes and tall grass, running west from Mud lake 8 miles or more before striking straggling timber.

is said to be a stream "very crooked, sluggish and deep for 25 miles from its mouth at Thief lake," from which I infer that it must have a total length of 40 miles or more. The country about it is as yet unsurveyed.

Basil lake, on the Thief, between Mud lake and Thief lake, has meadows and marshy land on both sides of it. The banks along Thief river, just below Thief lake and between that body of water and Basil lake, are high and "covered with hardwood timber," and the point of land between Thief river and Thief lake (marked p p) on the map, is timbered with oak, ash and elm. Beyond these high banks on Thief river, *i. e.*, west of them, the country is marshy.

Supposing one to be descending the river in a canoe, a ride of about 25 or 30 miles from Thief lake brings him to Mud river and turning into that stream he reaches Mud lake after a half hour of paddling. This lake is nearly 10 miles long and 4 to 6 wide, with an average depth of 4 feet. The bottom is soft mud but the water is clear and sweet. The banks are fringed with cane, rushes and wild rice, though the center of the lake is free from such growth. The surface of the lake is dotted with numerous islands, ten or more. Some were grassy knolls or knobs rising from the water (as No. 9), while others attain the hight of three or four feet above the surface, contain an acre or more of land, and are covered with tall timber. On the northeast side of Mud lake is a dense forest of tamarac and back of it slightly rising ground. Island No. 1 was the only one visited, rough weather during my short stay there not allowing of much canoeing. This island contained about an acre and a half and was covered with ash, elm, willow, and, I think, oak. In places on it I found large limestone rock; its beaches were composed of a clayey sand, and from its northern end ran a large sand-bar, on which were a few granite boulders about four feet in diameter.

The islands are apparently more numerous at the eastern end than near the outlet on the northwestern shore, and I have so indicated them on the map.

The muddy estuary *H.* on the west end of the lake and connected with it by a very shallow weed-grown passage, has a depth scarcely twelve inches, contains numerous low, grassy islands, roosting places of aquatic fowl, and opens again into

Thief river, about a mile below the mouth of Mud river by a narrow passage, which I have marked (i) on the map, just wide enough for two canoes to pass one another.

Paddling down the Thief from the mouth of Mud river, one reaches, in a few minutes, the narrow opening (i) through which a glimpse of the muddy estuary H is obtained. Continuing down stream, the canoe gliding swiftly along with the current, the banks are lined for a distance of about twenty miles with tall cane, six or eight feet high, which stretches back some distance from the river. This occurs on both sides but is rather more abundant on the Reservation side. On this part of the river there is no timber with the exception of a little scrub willow, mostly at a distance from the stream.

After that distance of twenty miles has been passed however, and after going through a region which has been burnt over and has dead tamarac standing upon it, the timber is continuous, almost entirely on the Reservation side, for a distance of ten miles or more, to Red Lake river into which the Thief empties.

This timber consists of willow, poplar, elm, ash, sugar maple, and oak, with small growth of Prickly Ash (Xanthoxylum americanum), hazel bushes, high bush cranberries (Viburnum opulus), wild plums (Prunus americana), wild grapes and rosebushes.

On the opposite side of the river, most of the land of any value has been claimed. The farms are comparatively few in number, however, the land being so covered with brush that farmers have a hard time to obtain a living therefrom.

The river gradually widens from a width of ten yards at the entrance of Mud river to about thirty yards at its mouth on the Red Lake river. The current is fairly strong and the average depth is about two and one-half feet. In places there are rapids where occur large boulders of granite (from two to four feet in diameter) and limestone rock. These rocks and boulders, however, are not found in the river as one approaches Mud lake. The bed of the river is sandy with gravel in some places and the banks are clayey mud with occasional small fragments of limestone. The water of the river is slightly yellowish, and at date of visit (Sept. 1) very cold. At the mouth of the river, there is, or was this fall, an encampment of Red Lake Indians, and about eight miles up stream is another village which subsist

on fish and game, the former procured from a stone fish trap which runs across the river here in the shape of a V, the point down stream. This is easily passed in a canoe, however by temporarily removing a number of branches and rock, on one side. On our way to Mud lake we passed the remants of several of these traps that had been used for a time by the Indians and then abandoned.

The only drawback to this country becoming a favorite resort for sportsmen is its inaccessibility, for though it is comparatively easy to get to the mouth of the river, going by rail as far as St. Hilaire, and then teaming to the mouth, a distance of 18 miles, the transportation of camp equipage to Mud lake or beyond is a matter of no small difficulty. There are but few farms along the river, the last one being situate about 20 miles from the mouth. The people are very hospitable however, and never refuse a lodging, such as it is, to belated or weatherbound travelers. Again, though Mud lake lies, in a straight line only 15 miles from the mouth of Thief river, the country around the lake is of such a marshy nature, that teams can approach only within about 10 miles of the lake on the Thief.

These difficulties surmounted however, the large number of aquatic fowl along the river and at the lake would amply repay an enthusiastic sportsman for his trouble.

Very truly yours,

F. L. WASHBURN.

A few notes on Otter Tail County and Lake Mille Lacs—Topography—Archæology, etc.

Otter Tail County: The abundance of flint arrowheads and fragments of ancient pottery throughout this county I noticed particularly, though for that matter these relics are abundant throughout the State, I believe. The pieces of pottery that I saw contained specks of pure silver, and scientists and many others, not scientists, when visiting that country have sought long but fruitlessly for the clay beds whence material for this pottery was obtained, thinking to find therein a boundless wealth of the ore.

Lake Mille Lacs: The country east of Brainerd, toward Mille Lacs, is rather bleak and dreary. Patches of second growth, and scrubby, bushy timber characterize the first part of the way, with an occasional long meadow filled with coarse wild grass. On our ride frequent belts of middling sized poplar were passed, and as we approached lake Mille Lacs, we met with more timber, oak, maple, birch, butternut, "butternut hickory" and soft pine, tamarac and spruce with some Norway and Jack pine. The distance from Brainerd to the lake is about 25 miles, and the road, which near the town is comparitively good, as it approaches the lake becomes rough, stony, and somewhat hilly.

Lake Mille Lacs, on account of its large size and the sameness of its shores, is not as attractive, I think, as many smaller lakes seen in Otter Tail county. Along the northwest shore the water is very shallow and the beach is sandy, and on the southeast shore, at one place the depth, for a mile from shore, does not exceed three feet. In other places, however, as on the south shore and along the north shore, the land is high and the banks are very precipitous and rocky, and the water close to shore is deep. Along the northwest shore for a distance of two miles or more is a very regular ridge, about 20 yards above the level of the lake, which with the beach makes a very well formed terrace, although probably formed by glacial action.

Near the southeast shore of the lake, about a mile from the land, there is said to be a broad granite ledge perfectly flat on top, which, at low water is about three feet above the surface and at high water just below the surface. Another outcrop of this granite is seen in townships south and west of the lake. Three barren and rocky islands a short distance from the southeast shore, the largest one containing about three-fourths of an acre, and known as Stone island (called Spirit island by the Indians) form breeding places for countless gulls.

In conversation with Mr. Johnson, an old salt-water sailor, who has lived on the lake for nine years, I learned that the Indians have never seen the lake so low as it is now.

Johnson is of the opinion, too, that Rum river has not always been the outlet from the lake, but that years ago the water found an exit by way of Knife river, some miles east of Rum river. Although the Knife is now but a small brook, he says that the

broad meadow overgrown with tamarac which extends many miles on both sides of the stream, shows indications of at one time being the bed of a large stream, and also says that on the high banks, at the edge of the meadow, he has found smooth, waterworn boulders.

His theory is that at some former time, when the water in the lake was much higher than it is now, not only did a stream run down the Knife river bed, but the water must have broken over the high banks then existing on the shore of the lake at Rum river and cut its way down through, eating out the channel which is now Rum river and cutting it down so low that its bed was below the bed of Knife river, so that now, the lake being much lower than formerly, the Rum river channel receives what water flows out.

Quoting from my diary of Nov. 8, I here write down the substance of a conversation held with Mr. O. E. Garrison, at lake Mille Lacs:

"South of lake Mille Lacs, at the very edge of the lake, and running southwest from Lake Superior to the southwestern part of Minnesota and beyond, is a line of granite which, theory says, is made by upheaval. In places it is covered with a layer of sandstone of the nature of drift. Again, in T. 24, R. 43, according to Garrison's map, near the center of the square, is a mass of granite, somewhat elevated, with a fissure on the northern side. In this region, two summers ago, about July 15th, Garrison was surveying with a friend and they found in that fissure, even at that date, a large amount of solid ice."

Mr. Garrison lives upon an old battle-field of the ancient mound-builders. Just back of his house are three mounds which would indicate that hostile tribes had a fight there at one time, and that the dead were interred on the spot. Running southwest from the mounds is an almost obliterated ridge averaging three feet in height. This ridge, he thinks, was at one time an old fortification of the mound-builders.

The largest of these three mounds is forty feet in diameter and from ten to fifteen feet high. This was opened a year ago and numerous skeletons found sitting upright, and so old that the thin pieces of bone crumbled away as soon as touched. In the same mound were found stone implements and weapons, and some pottery.

XI.

DGE.

N., May 27, 1886.

results of certain
Geological Survey,

Superior, No. 575,

45.47 per cent.
21.01 "
3.60 "
18.87 "
5.22 "
4.10 "
.16 "
.21 "
.93 "
.83 "

0.40

vell at Brown's

		Grains per U. S. Gallon.
		.7583
		.0233
		.0408
		3.0215
		1.6270
		84.7302
phosphate, $Ca_3(PO_4)_2$ ..	5.00	.2916
Sodium chloride, NaCl	912.70	53.2378
Potassium chloride, KCl	traces.	
Carbonic acid, Co_2	traces.	
Nitrates	traces.	
Total mineral matter	2464.10	143.7305

Test for organic matter, with permanganate of potash, amount of oxygen consumed, 1.63 parts per million.

This water is remarkable for the large amount of sulphates.

Chem. Series No. 176. This number was a sample of cupriferous rock. It was assayed by myself, for gold, silver and copper. The results of the assay were as follows:

Gold	$\frac{1}{10}$	Troy ounce per ton.
Silver	$\frac{3}{10}$	" " "
Copper	$\frac{47}{100}$	of one per cent.

Chem. Series No. 177. This was also a sample of cupriferous rock. It was assayed with the following results:

Gold	$\frac{8}{100}$	Troy ounce per ton.
Silver	$\frac{1}{10}$	" " "
Copper	$\frac{11}{100}$	of one per cent.

Chem. Series No. 178. Kaolin brought by Col. J. B. Clough in February, 1836.

Silica, SiO_2	49.66	per cent.
Alumina, Al_2O_3	37.29	"
Peroxide of iron, Fe_2O_3	.76	"
Lime, CaO	.61	"
Magnesia, MgO	.02	"
Potash, K_2O	1.23	"
Soda, Na_2O	.71	"
Water, H_2O	9.72	"
Carbonic acid, Co_2		traces.
Organic matter		traces.
	10000	

The analysis shows that this is a kaolin of good quality. It is comparatively free from oxide of iron and lime. The small amounts of oxide of iron, lime, magnesia, potash and soda would not, in my opinion, interfere with its use for the usual purposes to which kaolin is applied. The water reported in the analysis belongs to the chemical composition of the substance and would only be expelled by burning. The mineral was analyzed after drying at a temperature not exceeding 100 degrees centigrade.

Very respectfully yours,

JAMES A. DODGE,

Professor of Chemistry.

XII.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell:

DEAR SIR:—I have the honor to report that while relaxing no measures hitherto employed in the acquisition of all information possible relating to the avi-faunæ of the state, I am pursuing the preparation of a report as fast as the onerous demands of my other duties will permit.

By personal observations, and a somewhat extended correspondence with gentlemen competent to communicate reliable information in different parts of the state, together with the invaluable aid of Mr. F. L. Washburn, who spent some time in field-work last fall in the Red River Valley, I am able to report progress in still accumulating valuable facts to be embodied in the report, which but for reasons known to you, and a prolonged detention by sickness, would have ere this been closed. The labor has been much greater than my experience had anticipated, especially in consideration of the impossibility of consecutive engagement in it. I hope now before a great while to finish the land birds, and enter upon the water birds, which will be very much less voluminous.

Very respectfully yours,

P. L. HATCH.

1015 Mary Place, June 1st, 1886.

APPENDIX.

NOTES ON SOME DEEP WELLS IN MINNESOTA.

(*Continued from page* 16.)

The deep well at Albert Lea. The drillings from this well, which is 300 feet deep, were furnished by mayor A. C. Wedge. The well was made by Mr. Swanson in the summer of 1885. This well is situated in the high level near the business portion of the city, and the water stands at 22 feet below the surface. About 60 rods from this well Mr. William Morin sank another, beginning at a lower level, in the bed of what was once Spring lake, and penetrated to the depth of 204 feet. Flowing water in this well was obtained at 120 feet, but the well was continued deeper with a hope of getting a stronger flow. The discharge is about 400 barrels per day, of good quality and a temperature of 50 degrees, Fah. The drillings of this well have not been examined, but it is the opinion of mayor Wedge that the strata struck proved to be about the same as those given below as far as the drill penetrated. The water is apparently of the same quality. The iron films from the depth of 165 feet were derived from a bucket which became fast in the well and was drilled out.

1. Mus. Reg. No. 6191. Drift gravel largely limestone, from the depth of............ 80 feet.
2. " " " 6192. Drift sand and gravel, from.................................. 95 feet.
3. " " " 6193. Drift sand, mainly quartz, from..............................105 feet.
4. " " " 6194. Drift gravel and sand, from.................................112 feet.
5. " " " 6195. Drift sand, from..113 feet.
6. " " " 6196. Drift sand, with magnesian limestone, from..................114 feet.
7. " " " 6197 and 6198, Magnesian limestone and sand, from...................115 feet.
8. " " " 6199. Drift sand, with some limestone, from.......................130 feet.
9. " " " 6200. Magnesian limestone, with a few grains of drift sand, from..143 feet.
10. " " " 6201. Light-gray shale, slightly effervescing,....................155 feet.
11. " " " 6202. " " " " ....160 feet.
12. " " " 6203. Battered films of metallic iron, somewhat rusted, from.......165 feet.
13. " " " 6204. Gray shale, sandy, effervescing, with some films of iron, from.172 feet.
14. " " " 6205. Gray shale, from..210 feet.
15. " " " 6206. Gray shale, from..213 feet.
16. " " " 6207. Calcareous shale, nearly white, from........................220 feet.
17. " " " 6208. Compact, light-colored limestone, mixed with some drift-sand from above, or some arenaceous stratum, from.........................230 feet.

ings have a mixed composition; though mainly of mag-
different grain and color; also containing considerable
d fine crystals of silica referable to geodes in the rock;
stinctly arenaceous, from .... 234 feet.
ly white quartz sand, rounded and also angular; the
stone, readily effervescing; both are in fine grains and
.... 2`6 feet.
as the last, from .... 237 feet.
as the last, from .... 240 feet.
ly a homogeneous, buff, magnesian limestone, with some
.... 241 feet.
drillings consist, mainly of the same, light-buff mag-
ntain also numerous pieces of a dark earthy shale, not
stible, from .... 243 feet.
sh-buff magnesian limestone, with some fragments of
some rounded sand, from .... 248 feet.
as the last, from .... 250 feet.
ame without silica and sand, from .... 25? feet.
ish-buff, compact, magnesian limestone, from .... 258 feet.
ame, from .... 260 feet.
sh-buff, compact, magnesian limestone, mottled with
.... 265 feet.
ame, without gray mottlings, but with some chert and
.... 270 feet.
t-gray to buff, crystalline magnesian limestone, with
laments, from .... 275 feet.
nagnesian limestone, from .... 285 feet.
-buff magnesian limestone, some of the drillings being
d, resembling a light gray shale, from .... 295 feet.
ılar, buff, magnesian limestone, resembling the upper
tone, from .... 300 feet.

to serve as a guide in assigning these
ıeir geological horizon. There is, in the
ickness of about 186 feet of limestone
very much lithologically, extending from
It is shaly in some places, and also arena-
ters would not preclude the Galena lime-
stone, ... is thought to be the most probable rock in that geographical area. If, however, the Devonian limestones extend as far north as Albert Lea, these beds could all be assigned to that age, as far as their lithology is concerned, except Nos. 33 and 34 which have a greater resemblance to the Niagara. This would bring the Devonian upon the upper Silurian, as supposed in the deep well at Austin. The shale extending from 155 to 220 feet, a thickness of 65 feet, would, in that case, represent the Austin rock, and the mixed and arenaceous beds extending from 220 feet to 240 feet would parallelize with the conglomerate of the Austin well. There would be then 45 feet of magnesian limestone in the Albert Lea well, below the

conglomerate horizon, before the lithology of the Niagara is recognizable. This would fall into the upper part of No. 8 of the Austin well.

Joseph Goar's well, near Morristown, Rice County. This peculiar well was noted in the final report on Rice county. (vol. i, p. 671.) It is in N. E. ¼ sec. 33, Morristown. In a recent communication Mr. Goar gives more particulars concerning the action of this well.

It was dug fourteen years ago, to the depth of seventy feet. At about twenty feet, sand was struck with occasional beds of gravel, largely consisting of limestone. At fifty feet a sound resembling escaping steam was heard. The well being curbed as fast as dug little more was heard or noticed of this. Water to the depth of sixteen or eighteen inches was secured. The well was open, water being drawn by a bucket. In winter the bucket would freeze fast, and finally the whole surface was permanently frozen solid till warm weather came again. Then it was found that when the wind was strong from the north, or a little east or west of north, water could not be got, but a few hours wind from the south or southeast would insure plenty of water. At first it would look as if it had been agitated by wind, but soon became clear. Small black frogs, "with feet like chickens, no web between the toes," were sometimes drawn up, were said to have been drawn up often. These were so small they would get inside the links of an old fashioned trace chain.

More lately the well has been sunk about five feet deeper, an iron pump and pipe put into it, and filled up about seventeen feet with gravel and the opening at the top covered. It is now found that a strong current of air passes sometimes in and sometimes out of the top. The water is clear and softer than the common well-water of the country round. By keeping the well closely covered there is but little trouble from freezing. When it blows out it thaws everything about the top. The force of air going in or out, if confined to a small vent, has been heard at a distance of a hundred yards.

This can only be explained by supposing some connection with the surface through gorges in the rock, or through some gravel bed. The condition of the surface of the country, in Morristown,

prior to the drift epoch, may have been somewhat like that in Winona and Houston counties, and after the deposition of the drift some subterranean passages were still unfilled.

The Tracy deep well. This well was drilled by Messrs. Swan and Stacey, in the winter of 1885-86. Its depth is 724 feet four inches, and penetrates the granite about thirty-one feet. Water was found at about one hundred and fifty feet, which rose to within about thirty-seven feet of the surface. It did not apparently change in respect of hydrostatic pressure after it was first struck.

Through the courtesy of Hon. W. O. Musser, president of the village council, and the co-operation of Messrs. Swan and Stacey, the subjoined record of the depths of the different strata of this well has been obtained. This record was accompanied by a set of drillings, and from these the writer has made out the descriptive notes. The corresponding numbers of the museum register are 6492 to 6516.

No. of Sample.	No. of feet deep.	Total No. of feet.	DESCRIPTION.
1	1	1	Black loam soil.
2	19	20	Yellowish, pebbly clay.
3	100	120	Blue till.
4	5	125	Fine gravel, largely of limestone, having a nearly black general aspect, owing to fine disseminated organic matter. This contains some fine sand. and some soil-like matter. It also contains a few fragments of slag or furnace-clinker, of vegetable fiber, Cretaceous lignite, small pieces of pyrite apparently from the Cretaceous, and fibers of metallic iron evidently from the drill
5	20	145	Fine blue clay, Cretaceous?
6	20	165	Coarse gravel, embracing numerous pieces of buff limestone, and of crystalline rock, also of grey and dark or reddish quartzyte, pieces ranging from an inch in diameter to a thirty-second part of an inch, or finer. The whole being dirty and looking as if gathered on the surface of the ground in the soil and unwashed. There are in this lot several pieces of grey, gritty quartzyte evidently from the Cretaceous, and of grey conglomerate or coarse sandstone, and of concretionary iron pyrites. But the most singular portion is the slag similar to that mentioned in No. 4. This shows all stages of solidification from loose light pumice to black obsidian, and to black sub-crystalline hard rock It is in fragments as large as three-fourths of an inch in longest diameter, and in pellets round as shot, no larger than the eye of a needle. It is nearly all black, and is often amygdaloidal, some of it being magnetic. Embraced in this lot are also beds of lignite and of concretionary pyrites. On one of the angular black masses of stone. evidently broken from the formation, are very evident remains of woody fiber, now in the form of charcoal Fibers of metallic iron are equally common in this as in No. 4.
7	12	177	Fine blue clay, evidently Cretaceous.
8	20	197	Fine sandstone, homogeneous, light greenish-blue, Cretaceous.
9	213	410	Dark gray shale, Cretaceous, occasionally containing a rounded small pebble of buff limestone.
10	60	470	Fine light-blue or greenish sand.
11	48	518	Blue clay or shale, not fissile but rather massive, with fine kaolinic and micaceous particles.
12	32	545	Cretaceous grit consisting of angular and sub-angular grains of white quartz, also embracing numerous pieces of concretionary iron pyrites.
13	5	550	Fine grey sandstone.
14	30	580	Blue clay, like that of No. 11.
15	7	587	Angular and rounded grains of sand, mainly white quartz, but also containing pieces of pyrite, and films of iron from the drill.
16	24	611	Dark, unctuous, fine clay.
17	8	619	White, kaolinic clay, becoming reddish, then bluish and gritty; mingled in the lot with sub-angular grains of quartz.
18	8	627	White and grey quartz sand, the latter in concretionary lumps, cemented by pyrite.
19	10	637	The same as the last, but containing kaolinic material.
20	25	662	White kaolin, clouded with blue clay, and containing some grit.
21	2	664	White angular quartz sand, grains opaque, containing dull, olive colored siliceous lumps apparently made up of a great number of small grains cemented; also some kaolin, some shale, and some pyrite.
22	2	666	The same as the last.
23	6	672	The same as the last, but finer, more rounded and more homogeneous.
24	18	690	White sand, mainly angular, fine and homogeneous, but containing some coarse grains of angular quartz and some kaolinic material, the latter apparently resulting from the decay of grains of feldspar after deposition in the sandstone.
25	2	715	Reddish orthoclastic granite becoming chloritic.

The most interesting thing about this record is found in Nos. 4, 5 and 6. Here we find, separating the drift from the more evident cretaceous beds, a remnant of the old soil which accumulated on the Cretaceous rocks during the Tertiary age. There are two gravelly deposits separated by a fine blue clay. This clay may be a representative of the Tertiary. The lower gravelly bed, containing much slag and coarse gravel, can be supposed to have accumulated on the Cretaceous after the withdrawal of the Cretaceous ocean; the slag coming from the combustion of the lignites contained in the strata, in the same manner as seen at the present time in Dakota and Montana, producing many of the phenomena of volcanoes. After a submergence, and the accumulation of twenty feet of (Tertiary?) blue clay, another soil accumulated over the blue clay similar in all characters to the former. On this, afterward, was brought the glacial till by the operations of the post-Tertiary age. This history is indicated by the presence of these igneous particles in the drillings from this depth, and it is no more than might be expected from the abundant ashes and charcoal that accompany the Cretaceous lignites in their exposures at and near Redwood Falls. These particles of slag, however, may have been adventitiously introduced in the drillings from some coal-stove or other fire-box; and this is strengthened by the fact that in No. 4 is also found a fragment of an eight penny nail of iron.

The deep well at Gibbon, on the Minneapolis and St. Louis railway. Sec. 2, T. 112, R. 31, Sibley Co.

This was drilled by the Minneapolis and St. Louis railway, and Mr. W. B. Hixson has supplied the following facts:

1.	Blue clay, dry, with small gravel-stones and an occasional boulder	275 feet.
2.	Sand, with water which rose forty or fifty feet above the sand; also containing remains of wood, having the appearance of modern drift-wood (6245 and 6246)	20 feet.
3.	Red granite (6247)	30 feet.

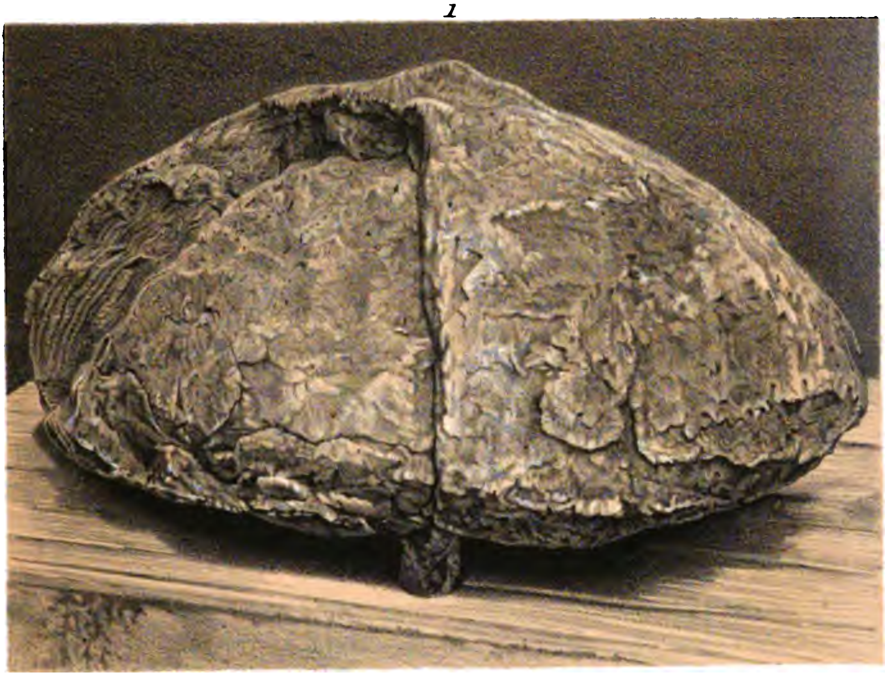
EXPLANATION OF PLATE I.

PAGE.

Cryptozoon minnesotense, n. sp. 313

1. View of the exterior of a large specimen showing a section of the Laminæ where a segment of the surface has been removed; also the undulating or knobbed upper surface of the laminæ. From a photograph, reduced from the natural size to about one-fourth.
2. View of the same specimen showing the base, reduced to one-fourth the natural size, from a photograph. This specimen, as represented, is coated on the bottom with a layer of calcareous tufa, which renders the concentric ridges much less evident and continuous.

1



2

EXPLANATION OF PLATE II.

PAGE.

Cryptozoon minnesotense, n. sp.............................. 313

3. View of a thin section, perpendicular to the laminæ; natural size.

PAGE.

Cryptozoon minnesotense, var *libertatis*, n. var............... 314

4. External appearance of an ordinary specimen; natural size. The upper end is nearly entire; the lower end shows a section across the concave base.

PAGE.

Rhynchonella ainsliei, n. sp............. 315

5. Front view of a mature specimen; natural size.
6. Profile view of a mature specimen; natural size.

PAGE.

Orthis remnicha, n. sp............. 317

7. External view of the larger valve; natural size.

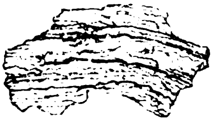
PAGE.

Orthis sandbergi, n. sp.................................. 318

8. Cast of the exterior of the larger valve; natural size.
9. Cast of the interior of the larger valve; natural size.

4

3



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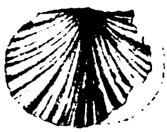

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

THE FIRST ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1872. 112 pp., 8 vo.; with a colored map of the State. By *N. H. Winchell*. Published in the Regents' Report for 1872. Out of print.

THE SECOND ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1873. 145 pp., 8 vo.; with illustrations. By *N. H. Winchell* and *S. F. Peckham*. Published in the Regents' Report for 1873. Out of print.

THE THIRD ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1874. 42 pp., 8 vo ; with two county maps. By *N. H. Winchell*. Published in the Regents' Report for 1874. Out of print.

THE FOURTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1875. 162 pp., 8 vo ; with four county maps and a number of other illustrations. By *N. H. Winchell*, assisted by *M. W. Harrington*. Also in the Regents' Report for 1875. Out of print.

THE FIFTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1876. 248 pp., 8 vo.; four colored maps and several other illustrations. By *N. H. Winchell*, with reports on Chemistry by *S. F. Peckham*, Ornithology by *P. L. Hatch* Entomology by *Allen Whitman*, and on Fungi by *A. E. Johnson*. Also in the Regents' Report for 1876. Out of print.

THE SIXTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1877. 226 pp., 8 vo.; three geological maps and several other illustrations. By *N. H. Winchell*, with reports on Chemical Analyses by *S. F. Peckham*, on Ornithology by *P. L. Hatch*, on Entomology by *Allen Whitman*, and on Geology of Rice county by *L. B. Sperry*. Also in the Regents' Report for 1877. Out of print.

THE SEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1878. 123 pp., 8 vo.; with twenty-one' plates. By *N. H. Winchell*, with a Field Report by *C. W. Hall*, Chemical Analyses by *S. F. Peckham*, Ornithology by *P. L. Hatch*, a list of the Plants of the north shore of Lake Superior by *B. Juni*, and an Appendix by *C. L. Herrick* on the Microscopic Entomostraca of Minnesota (twenty-one plates). Also in the Regents' Report for 1878.

THE EIGHTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1879. 183 pp., 8 vo.; one plate (Castoroides). By *N. H. Winchell*. Containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, and descriptions of new species of brachiopoda from the Trenton and Hudson River formations; with reports on the Geology of Central and Western Minnesota, by *Warren Upham;* on the Lake Superior region, by *C. W Hall;* lists of Birds and of Plants from Lake Superior, by *Thomas S. Roberts;* Chemical Analyses by *S. F. Peckham;* report by *P. L. Hatch;* and four Appendixes. Also in the Regents' Report for 1879 and 1880. Out of print.

*The Ninth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1880. 392 pp., 8 vo.; three appendixes, two wood cut illustrations, and six plates. By *N. H. Winchell*. Containing field descriptions of 442 crystalline rock samples, and notes on their geological relations, from the northern part of the state; new brachiopoda; the water supply of the Red River Valley, and simple tests of the qualities of water; with reports on the Upper Mississippi region, by *O. E. Garrison;* on the Hydrology of Minnesota, by *C. M. Terry;* on the Glacial Drift and its Terminal Moraines, by *Warren Upham;* Chemical Analyses by *J. A. Dodge;* a list of the Birds of Minnesota, by *P. L. Hatch;* and of the Winter Birds, by *Thomas S. Roberts*. Also in the Regents' Report for 1879 and 1880.

*The Tenth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1881. 254 pp., 8 vo.; with ten wood cut illustrations, and fifteen plates. By *N. H. Winchell*. Containing field descriptions of about 400 rock samples, and notes on their geological relations, continued from the last report; the Potsdam sandstone; typical thin sections of the rocks of the Cupriferous Series; and the deep well at the "C" Washburn mill, Minneapolis; with Geological notes, by *J. H. Kloos;* Chemical Analyses by *J. A. Dodge;* and papers on the Crustacea of the fresh waters of Minnesota (eleven plates), by *C. L. Herrick*. Also in the Regents' Report for 1881 and 1882.

*The Eleventh Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1882. 219 pp., 8 vo.; with three wood cut illustrations and one plate. By *N. H. Winchell*. Containing a report on the Mineralogy of Minnesota, and a note on the Age of the rocks of the Mesabi and Vermilion iron districts; with papers on the Crystalline rocks of Minnesota, by *A. Streng* and *J. H. Kloos;* on Rock outcrops in central Minnesota, and on Lake Agassiz, by *Warren Upham;* on the Iron region of Northern Minnesota, by *Albert H. Chester;* Chemical Analyses by *J. A. Dodge;* and an Appendix containing Minnesota Laws relating to Mines and Mining, abstracted by *C. L. Herrick*. Also in the Regents' Report for 1881 and 1882.

*The Twelfth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1883. Summary report, containing palæontological notes, and a paper on the comparative strength of Minnesota and New England granites, 26 pages, by *N. H. Winchell*; final report on the Crustacea of Minnesota included in the orders Cladocera and Copepoda. 192 pages and 30 plates, by *C. L Herrick*, and a catalogue of the flora of Minnesota, 198 pages, with ore map showing the forest distribution, by *Warren Upham*. Also in the Regents' Report for 1883-84.

*The Thirteenth Annual Report on the Geological and Natural History Survey of Minnesota for the year 1884. 196 pages. Geological reconnoisances, the Vermilion iron ores, the crystalline rocks of Minnesota, and of the Northwest, the Hum bolt salt-well in Kittson county, records of various deep wells in the state, fossils from the red quartzyte at Pipestone, reports on the New Orleans Exposition and on the General Museum, by *N. H. Winchell;* Geology of Minnehaha county, Dakota, by *Warren Upham;* Chemical report by *Prof. Jas. A. Dodge;* Minnesota geographical names derived from the Dakota language by *Prof. A. W. Williamson;* insects injurious to the cabbage, by *O. W. Oestlund;* Geological notes in Blue Earth county, by *Prof. A. F. Bechdolt*, and on a fossil elephant from Stockton by *Prof John Holzinger;* papers on the Cretaceous fossils in the boulder clays in the Northwest by *George M. Dawson* and by *Woodward* and *Thomas*, and notes on the Mammals of Big Stone Lake and vicinity by *C. L. Herrick*.

II. FINAL REPORT.

*The Geology of Minnesota. Vol. I. of the Final Report. 1884; xiv and 697 pp., quarto; illustrated by 43 plates and 52 figures. By *N. H. Winchell*, assisted by *Warren Upham*. Containing an Historical sketch of Explorations and Surveys in Minnesota, the general Physical features of the state, the Building stones, and the Geology of Houston, Winona, Fillmore, Mower, Freeborn, Pipestone, Rock and Rice counties, by *N. H.*

Winchell; the Geology of Olmsted, Dodge and Steele counties, by *M. W. Harrington;* and the Geology of Waseca, Blue Earth, Faribault, Watonwan, Martin, Cottonwood, Jackson, Murray, Nobles, Brown, Redwood, Yellow Medicine, Lyon, Lincoln, Big Stone, Lac qui Parle and Le Sueur counties, by *Warren Upham.* Distributed gratuitously to all public libraries and county auditors' offices in the state, to other state libraries and state universities, and to leading geologists and scientific societies; the remainder are held for sale at the cost of publication, $3.50 per copy in cloth, or $5 in grained half roan binding, upon application to Prof N. H. Winchell, Minneapolis.

III. MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR No. 1. A copy of the law ordering the survey, and a note asking the co-operation of citizens and others. 1872.
2. PEAT FOR DOMESTIC FUEL. 1874. Edited by *S. F. Peckham.*
3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. A history of all official transactions relating to them, and a statement of their amount and location. 1874. By *N. H. Winchell.*
4. A CATALOGUE OF THE PLANTS OF MINNESOTA; prepared in 1865 by *Dr. I. A. Lapham,* contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.
5. CIRCULAR No. 2. Relating to botany, and giving general directions for collecting information on the flora of the state. 1876.
6. CIRCULAR No. 3. The establishment and organization of the Museum. 1877.
7. CIRCULAR No. 4. Relating to duplicates in the Museum and exchanges. 1878.
8. THE BUILDING STONES, CLAYS, LIMES, CEMENTS, ROOFING, FLAGGING AND PAVING STONES OF MINNESOTA. A special report by *N. H. Winchell.* 1880.
9. CIRCULAR No. 5. To Builders and Quarrymen. Relating to the collection of two-inch cubes of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum. 1880.
10. CIRCULAR No. 6. To owners of mills and unimproved water-powers. Relating to the Hydrology and water-powers of Minnesota. 1880.

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

THE FIFTEENTH ANNUAL REPORT

FOR THE YEAR 1886.

N. H. WINCHELL, State Geologist.

Submitted to the President of the University, May 1st, 1887.

ST. PAUL:
PIONEER PRESS COMPANY.
1887.

I. C. Russell
Washington 1888.

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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, May 1, 1887.

To the President of the University,

DEAR SIR: I herewith communicate the fifteenth annual report of progress of the geological and natural history survey of the state.

With great respect,
Your obedient servant,
N. H. WINCHELL,
State geologist and curator of the general museum.

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GENERAL CONTENTS.

*

REPORT.

I.

SUMMARY STATEMENT.

As intimated in the last report, the field work was renewed in 1886, in the northern part of the state. Three parties, organized and equipped for geological observations, were set at work with headquarters near Tower, on the south shore of Vermilion lake. These were under the personal direction of Dr. M. E. Wadsworth, of Waterville, Dr. A. Winchell, of Ann Arbor, and myself. From a central supply camp they were sent out on trips designed to occupy a couple of weeks each, more or less, returning for supplies and to deposit and ship the specimens they had collected, at the end of each trip. At the same time a party of botanists, under the direction of Prof. J. C. Arthur, scoured the country about Tower, for plants, both phænogamous and cryptogamic, making a large collection.

It was found, however, as the season advanced, and owing to the health of Dr. Wadsworth, that it was necessary to vary from the plan with which the work opened. The distance from the base of supplies kept increasing; and on account of the great difficulties of travel, and the time consumed in getting back to Tower, it was found desirable to move the supply camp to a point about forty miles further east. This was on the south shore of Fall lake, at the mouth of the Kawishiwi river. The fatigue and hardship being too great for Dr. Wadsworth's health, he was relieved of field work, and was given a systematic microscopic examination of some of the igneous rocks of the northern part of the state, of which many thin sections had already been made by the survey. This occupied him during the rest of the season, the work being done in the laboratory of the survey at Minneapolis. While this weakened the force in the field it did not retard the actual progress of the survey, since this microscopic work had to be done on this group of rocks. In a

measure, Dr. Wadsworth's place in the field, at the head of one of the parties of observation, was supplied by so arranging the minor excursions that one of them could be conducted by some of the younger geologists.

The number of men engaged, at different times during the season, including the botanists, varied from eight to fourteen. The names of the gentlemen connected with the scientific field work during the season are as follows:

N. H. WINCHELL, generally assisted by Mr. U. S. GRANT who also made collections of fresh-water shells, and notes on the avi-fauna, for Dr. P. L. Hatch; but in the fore part of the season assisted by Mr. H. V. Winchell.

A. WINCHELL, generally assisted by Mr. F. N. STACY, but assisted in the fore part of the season by Mr. A. W. JONES.

M. E. WADSWORTH, assisted, while in the field, by Mr. U. S. GRANT.

Some independent observations were made, on short trips, under the direction of Messrs. H. V. Winchell, Stacy and Jones.

J. C. ARTHUR, assisted by L. W. BAILEY, JR., and E. W. D. HOLWAY; also by Mr. A. W. JONES.

Each party consisted of three men — the geologist who devoted himself entirely to his note book, instruments, township plat and specimens; his assistant who was always ready to carry specimens, dress out rock samples, or serve his principal in any way needed, but when not so occupied was expected to lend his hand to the camping, canoeing or cooking, and an expert woodsman or voyageur who was familiar with the traveled routes and the geography of the region. These three, with their impedimenta, would comfortably fill the ordinary birchen canoe of the Indians, by means of which all such traveling has to be done in the region examined.

The geologists were on the ground a little after the first of July, although the permanent camp was established and some field work was done before the fifth of June. The party returned to Minneapolis about September 20th. The extra expenses for the season's field work reached nearly $3,500, but this included the purchase of some apparatus and material which will be of use another season.

The report of Dr. A. Winchell, on his work on the crystalline rocks in the northeastern part of the state, is included in the following pages. This embraces a profusion of detailed obser-

vations, followed by some generalized statements on the stratigraphy, and will be of value in the future study of the systematic geology of this great series of rocks.

The report of Dr. M. E. Wadsworth on the microscopic examination of some of the igneous rocks of the state, though one of the important results of the year's work, will be issued as a bulletin, separate from the report of progress, according to the terms of a law of the late legislature entitled *an act to extend the work of the geological and natural history survey.*

Prof. Arthur's report of progress on the botany of the state, including observations by himself and Messrs. Bailey and Holway, and a contribution by Mr. Warren Upham, will also be issued as a separate bulletin. Very substantial nd important advance was made in the botanical department of the survey by the work of last season, and large additions were made to the survey herbarium.

In a similar manner Mr. Oestlund's current report on the Aphididæ, being a systematic memoir on the family, will be delayed temporarily in order that it may embrace the observations and study of another season, and will appear as a bulletin of the same series.

Prof. C. L. Herrick has submitted a large part of his final report on the mammals of the state, but a portion of it remains still in his hands. As soon as it can be completed it will be put to press.

Dr. P. L. Hatch is still engaged on his final report on the ornithology of the state, and is bringing it to a close as rapidly as possible. It is intended to include it with Prof. Herrick's on mammals, in one of the final volumes of the survey report.

Numerous accessions have been made to the museum collections, and to the material which represents the field work of the survey. The latter, in the main, are not entered in the regular museum lists which follow, but are registered by another series of numeration and reserved for further study. The cases that are designed for the exhibition of specimens are full, and the rooms containing them are not large enough to accommodate any further display. It is hoped earnestly that ere long the museum may be removed to better quarters with ample accommodations.

The printing of vol. II of the final report has been unwarrantably and culpably delayed by the contractors. At this date (April 15, 1887) the manuscript has been in their hands nearly twenty-one months, and without any justifiable excuse for delay

with continual urging and remonstrance on my part, met with voluble and reassuring promises of immediate action on theirs, they have not yet completed the first two chapters, and have lithographed but two of the plates. At the rate at which the work has progressed during the past two years, it will require more than twenty years before the volume is issued.

The following report is taken up very largely with the geology of the iron-bearing rocks. Within the past two years a great interest has been awakened in the iron industry in the Northwest. The success of the pioneer company, the *Minnesota Iron Company*, has attracted general attention to northern Minnesota as an iron-producing country, and numerous inquiries are made for some information, as full and authentic as possible, on the geology of these rocks, and for maps giving their distribution. It is with a view to supply this demand, as amply as the survey is able at present, that this character is given to this report.

It should be understood that the tentative conclusions which the observations of the season have seemed to warrant, respecting the stratigraphy and genesis of the rocks of this part of the state, so far as they are expressed in this report, are merely tentative, and are given in order to group the observations into some systematic scheme, to make the details somewhat more intelligible by the reader. They are intended to express the most apparent and ready explanation of the facts. The mineralogical determinations are only such as were made in the field, there having been no opportunity to study the specimens with greater care, nor even to open the boxes in which they were packed.

The name *Vermilion group* as used in the following report is intended to include a portion of the complex series of schists which in the late report of the Canadian geological and natural history survey has been designated *Kewatin series*, by Mr. A. C. Lawson. It embraces the mica-hornblendic schist rocks that appear at the northwest extremity of Vermilion lake, and their equivalents at the west end of Birch lake as well as their extension eastward from Vermilion lake to Basswood lake. This group lies between the graywackes on one side and the basal syenites and granites on the other, thus covering only the lower portion of the *Kewatin series*.

II.

REPORT OF A. WINCHELL.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

N. H. WINCHELL, STATE GEOLOGIST.

REPORT

OF

GEOLOGICAL OBSERVATIONS

MADE IN

NORTHEASTERN MINNESOTA

DURING THE SEASON OF 1886.

Accompanied by a Geological Map and 57 Structural Illustrations.

BY ALEXANDER WINCHELL,
PROFESSOR OF GEOLOGY AND PALÆONTOLOGY
IN THE UNIVERSITY OF MICHIGAN.

(Part II of the Annual Report of Progress for 1886.)

ST. PAUL:
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1887.

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LIST OF ILLUSTRATIONS.

REPORT OF A GEOLOGICAL SURVEY IN MINNESOTA DURING THE SEASON OF 1886.

BY ALEXANDER WINCHELL.

1.—PRELIMINARIES.

The region reported on. The writer submits a report of geological field-work done during July, August and September, 1886, under instructions from the state geologist of Minnesota. The region examined lies in the northeastern portion of Minnesota, north of the western part of lake Superior. It stretches in a direction north of east from Vermilion lake to Knife lake and Ogishke-Muncie lake and somewhat beyond. It lies between ranges 5 and 15, west, and towns 62 and 66, north—extending into twenty-four different townships. There are no public roads within the region, and it can scarcely be said that the least improvement for facilitating travel has ever been made by public authority. Not over half a dozen settlers were seen in all the region, and these were located in the cheapest log cabins, where the time was spent in awaiting the maturity of their titles to the legal allowance of land and in looking up pine districts and iron-ore locations. Not a single Indian was found resident in the district, and only about four square rods of soil were found cultivated.

Means of communication. The exclusive mode of travel and transportation is by birch bark canoes of Indian manufacture. A canoe 16 to 18 feet in length will carry three men and the requisite baggage for camping, provisions and work. Between the lakes portages are made, the canoe being transported by itself, generally on the head and shoulders of one man, and the baggage being separated into as many bundles as necessary. The portages over the routes most traveled are from a quarter of a mile

to more than a mile in length. They are simply winding footpaths leading by the nearest practicable route over plains and rocky hills and across swamps and bogs. The best have at some time been cut out sufficiently for the transportation of the canoe, but the portage trail consists chiefly of a path more or less beaten by long continued Indian travel. On some of the principal trails the path is in places deeply worn, but always narrow. On other trails the marks of travel are so obscure that much difficulty arises in picking the way. The work of the past season rendered it necessary to traverse 123 portages, having a total length of 43 miles.

In the region east of Vermilion lake, the principal routes of communication are between the east and west. The direction has been determined by the location of the chief Indian settlements; in the east about Beaver bay and Pigeon river, and in the west, from Vermilion lake to the upper Mississippi and beyond. However, more fundamental than the location of settlements, was the disposition of the great natural features of the country, which predetermined the trends of most practicable communication. Thus the situation of the interior lakes rendered travel between east and west vastly easier than between north and south. From Vermilion lake eastward the great thoroughfare may be described as follows: At the northeastern corner of Vermilion lake, the route passes to the head of Mud Creek bay, and thence through Mud creek, including a portage, and two Mud lakes, thence by portage to Burntside lake, thence by portage to Long lake, and thence to Fall lake. From the eastern extremity of Fall lake is a route over the rapids northwards into Basswood lake, and another by portages into another arm of Basswood lake, and along the national boundary eastward, leading across the portage into Carp lake, and the succession of waters toward Knife lake; from Fall lake is another principal route, leading by portage to Garden, Farm and White Iron lakes. The portages will be particularly noticed in the following report, and will be found properly located on the accompanying map.

Not a little surprise has been experienced that the principal portages have been left so long without improvement at the hand of civilization. Tower is a settlement of two or more thousand, and transacts a considerable business with regions lying to the eastward. Hunters, settlers, explorers and Indians must find exit eastward over these portages and must transport all their provisions and other supplies over them. Everything

destined for Tower must be got over these portages. One would imagine a town so dependent on facilities of exit and approach, would seek to improve its highways. But the very first portage, within six to eight miles of Tower, is one of the most execrable in the region; and when the water is low the difficulties of the transit through Mud creek are very great. Then the portage also from Mud lake to Burntside is obstructed by logs, rocks, loose stones and a long stretch of scarcely passable marsh. Five hundred dollars would put this portage in a condition suited for civilized transit. Two hundred dollars would suffice to lay one or two stretches of hewn logs across this swamp. As these lands are largely public lands, the subject of improvement of transportation would seem to be a legitimate one to bring to the notice of the public authorities, either of the United States, the State or the County.

The inland lakes. The country through which these explorations have extended is dotted by numberless small lakes, separated from each other by intervals varying from a quarter of a mile to two miles. All the larger lakes present an elongated form, having a length two, three or four times their breadth. The longer axis trends generally north of east, in conformity with the rocky structure which has determined the forms and positions of the lakes. Their shores are generally rocky, and rise to altitudes of 10, 15 or 20 feet; though in occasional instances the cliffs attain elevations of 50 to 80 feet. Some portions of the shores are covered by a thin sheet of drift material, or more generally by the angular débris and earthy products of atmospheric destruction. In portions of the district the outcropping rocks are mostly bare, but in others they are covered by a dense cushion of mosses. It is probable that in regions where the original forest has been burned, the mosses have been removed by fire or destroyed by exposure to the rays of the sun.

Character of the report. The general results of the observations of the past season can not at present be fully formulated, for the reason that the general views to be entertained respecting any portion of the region depend partly on observations extended over the whole region—from Vermilion lake to Thunder bay. That region is a unit, and each part must be interpreted in the light of the whole. It is impossible, therefore, to offer a concise digest of conclusions. The attempt, likewise, to offer a digest of the facts as far as observed would simply rob the reader of a portion of the data requisite to form his own provisional conclu-

sions. With the knowledge that more or less of the facts are kept back, the reader would feel compelled to hold even provisional conclusions in abeyance; and in fact might well feel that the consideration of a portion should be postponed until the presentation is made complete. Were the details of fact destined to appear in a final report, their appearance is likely to be delayed for an inconvenient period; while the questions presented by the geology of the region possess immediate and living interest. But it is even doubtful whether the full details will be admissible in a final report. It has seemed, therefore, on consideration, that this is the time and place to offer a full statement of the facts as observed.

These facts will be grouped about the principal lakes of the region rather than thrown in the form of an itinerary. The facts thus, which are geographically related to each other, will be brought into juxtaposition with each other and with the great natural features of the country. This will aid in the mastery of the subject, and facilitate future reference.

Following these details, however, will be a general summary intended for the use of the more casual reader.

Locality numbers. The references to the localities are precise, designating not simply the square mile but the particular forty acres on which the observation is made. Each locality, moreover, receives a special-serial number, and is briefly referred to as "Halt" so and so. In designating localities the usual formula of the land surveys is employed; but to obviate unnecessary repetition, the terms "township" and "range" are omitted, since the "township" is always "north," and the "range" is always (in this report) "west" of the "fourth meridian, Minnesota." Thus, "N. E. ¼, S. E. ¼, S. 8, T. 62–11," designates a certain "sixteenth" in section 8, of township 62, north, in range 11 west, of the 4th meridian, Minnesota.

Bearings. The bearings given refer to the true meridian. The mean variation of the needle within each township has been calculated from the records given on the government plats, and thus the proper correction for each township has been obtained separately.

Rock numbers. The rocks collected constitute another numerical series. The rock numbers must not be confounded with those employed by my brother in former reports — especially the ninth, tenth and thirteenth. Undoubtedly many of my rocks are duplicates of his, but it must be left to the future to point out equivalences.

Rock identifications. The identifications and descriptions of rocks are less authentic than could be desired. They were made almost wholly in the field, often under circumstances which rendered impracticable close scrutiny even with a pocket handglass —still more in the absence of reagents, blowpipe, compound microscopes and books. These specimens, packed in the field, boxed and shipped at once to the headquarters of the survey, have not since been seen. Their re-examination and adequate study are neeessarily postponed.

Use of terms. In the use of terms the author deviates slightly from the German authorities most respected at the present time, and from a portion of the American authorities. Good reasons seem to exist for this, but it is not necessary to set them forth in the present connection. The divergence will result in no misconceptions if announcement is made in advance of the sense in which terms are employed. The following are not intended for *complete* definitions: By *granite* is meant a non-schistose aggregate of quartz, orthoclase and mica. When schistose, the rock is *gneiss.*

By *syenite* is meant a non-schistose aggregate of quartz, orthoclase and hornblende. When schistose, the rock is *syenite gneiss.*

An aggregate of quartz and orthoclase is *granulyte;* and this may be *gneissic* or *schistose.*

An aggregate of hornblende and orthoclase is *hyposyenite.*

An aggregate of hornblende and an acidic plagioclase is *dioryte.* This may also be *schistose.* It may also be *quartzose.*

An aggregate of augite and plagioclase, whether basic or acidic, is *diabase.*

Noryte is an aggregate of hornblende or augite with a basic plagioclase.

Gabbro is a form of noryte to which the pyroxene (augite) is lamellar (diallagic) and the plagioclase is a cleavable labradorite. The texture is mostly coarse.

I have endeavored to employ the once-outlawed term "graywacke," but there is much difficulty in fixing on a precise definition. According to Zirkel, "graywacke" forms a "clastic rock of most diverse grains. It is composed of angular or rounded grains of quartz, generally in predominating abundance, formed from fragments of siliceous schist or argillyte, with which are not unfrequently associated grains of feldspar, and in some varieties abundant mica scales, all cemented by a

binding material consisting of a clayey mass completely penetrated by silica, or even of silica alone. The siliceous clayey binding mass is often dark colored by finely divided particles of anthracite. The clastic elements mostly predominate over the binding mass, so that the latter is frequently difficult to distinguish. On account of the siliceous cement this rock posseses frequently, great toughness and hardness." In other words graywacke is essentially a fine, compact feldspathic sandstone with a silico-argillaceous groundmass.

Some use is made of the term *porodyte* introduced by Prof. M. E. Wadsworth (Bull. Mus. Comp. Zoöl. V, 280 and VII, 60). It is a rock having a greenish, compact, felsitic base, holding grains of quartz. In other words, it is a highly indurated feldspathic sandstone. It graduates into graywacke.

By *jaspilyte* I designate the siliceous, often jaspery, beds associated with iron ores. They are generally reddish, but often black, smoky, or colorless. The term is adopted from Wadsworth (Bull. Mus. Comp. Zoöl. VII, 76), but without any expression of opinion on the cause of the bedding.

The term *bed* and its correlatives is employed simply to denote a kind of structure. No implication is intended of the sedimentary or igneous origin of the bedding.

Principal lake regions. The geologic and physiographic data embraced in this report will be grouped about the following lakes: Vermilion lake, Mud creek and lake, Sand lake, Eagle Nest lakes, Burntside lake, Long lake, Fall lake, Garden lake, White Iron lake, Farm lake, Kawishiwi river, Basswood lake, Crooked lake, Iron lake, Newfound lake, Moose lake, Snowbank lake, Boot lake and vicinity, Ensign lake, Sucker lake, Knife lake, Ima lake, Thomas lake, Fraser lake, Kekekabic lake, Ogishke Muncie lake, Gabimichigama lake.

2.—VERMILION LAKE REGION.

The work of the season began upon the southeastern shores of this lake, but soon extended into the region lying eastward. The writer has little to say, therefore, of its geology. It is by far the largest lake in northeastern Minnesota, straggling over portions of townships 62 and 63 in ranges 15, 16, 17 and 18, west. Its coast line is extremely irregular and its surface is broken by scores of rocky islands. In recording my few observations I follow the order in which they were made.

HALT 1. S.W.¼, S. W¼, S. 20, T. 62-15. The rock here is hard and tough and of a gray color. It has been styled graywacke, and it certainly approaches the definition cited from Zirkel. It resembles Rocks 17, 18 and 19 (Halts 9 and 10,) to which reference is made. It exhibits bedding planes dipping at a high angle—nearly vertical, and having a strike N. 82° W. Two sets of joints appear, one north 78° east and the other N. 48° E. In the midst of the graywacke formation appears a dike-like form, which, however, on close inspection, appears to be bedded in the direction of its length, and many of its laminæ reveal, on the weathered surface, an elaborately complicated system of plications. This dike-like form resembles, in composition, the country rock. The whole is intersected by a sinuous vein of quartz porphyry.

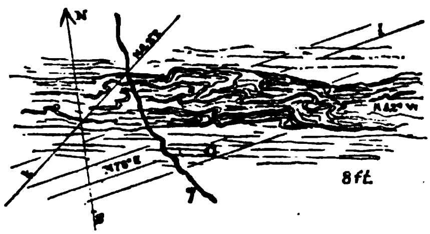

Fig. 1. Features observed at Halt 1, Vermilion L.
a, graywacke of the country rock.
g, dike-like bed of crumpled graywacke.
i, principal joints N 78° E.
k, second system of joints, N 48° E.
q, vein of quartz porphyry.

Rock 1. Graywacke from the country rock disposed parallel with the principal joints, N. 78° E. (See also Rock 71.)

Rock 2. Graywacke slate much plicated on weathered edge. Parallel with the bedding.

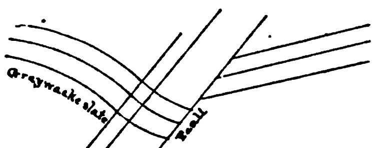

Fig. 2. Faulted condition of slate at Halt 2, Vermilion Lake.

HALT 2. Centre S. W. ¼, S.W.¼, S. 20, T. 62-15. Graywacke like that at Halt 1, but more slaty. Bedding strikes N. 84° W. Dip S. by W. 84°. Glacial striæ S. 8° W. A bed of porodyte-

like material 6 inches wide is included. The graywacke slate is faulted as shown below.

HALT 3. N.E. pt. S.W. ¼, S.E. ¼, S. 20, T. 62-15. Glaciated exposure of rock similar to last. Strike of bedding N. 85° W. Dip 88°. Glacial striæ S. 26° W. The country rock is slaty graywacke (rock 3) including a bed of porphyritically quartzose porodyte, which is elongated in the direction of the bedding, and itself inclosing irregular branching masses of quartz.

The beds of the country rock are rather various, ranging from graywacke slates, thick and thin, to argillyte.

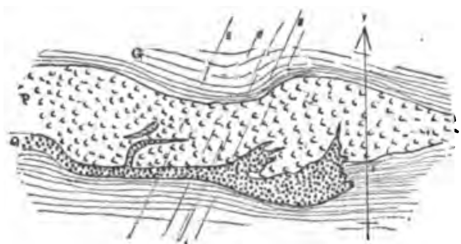

Fig. 3. Quartz included in porodite. Halt 3, Vermilion Lake.
G, graywacke slate. P, bed of porodite conformable with slate. Q, irregular masses of quartz in the porodite. [illegible] glacial striæ S 26 W.

Rock 3. Graywacke slate, thick.
Rock 4. Graywacke slate, thin.
Rock 5. Argillitic graywacke slate.
Rock 6. Argillyte.

These are all beds of country rock.

Rock 7. Porphyritically quartzose porodyte.

HALT 4. About twenty rods N. E. of Halt 3 (inland) is another exposure of a very complicated kind. Distinct bedding planes with beds of same porphyritic material — beds of porphyritically quartzose sericitic schist, beds of coarse poroditic conglomerate, beds of conglomerated blue jasper and quartz — all in a state of great confusion and mutual displacement. In the sericite rock are rounded fragments of quartz-jasper, around which the leaves of sericite rock are partly wrapped.

At Halt 4 we find successions like this: Argillyte, argillitic sericitic schist, same with quartz grains, beds of poroditic porphyry, beds of poroditic conglomerate, rounded and ragged masses of jasper-quartz sometimes brecciated, sometimes with quartz and jasper interlaminated. All these seem to be contemporaneous, all parts of one formation.

The jasper-quartz appears to have been introduced in the form of foreign fragments. The sericite is wrapped around the knobs and bosses of it, and even fills narrow intervals standing vertically between contiguous masses of it. It appears plain that these fragments were dropped in when the sericitic mud was accumulating.

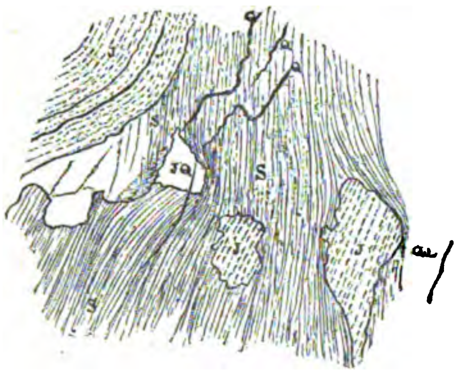

Fig. 4. Sericitic Schist and Inclosures; Half 4.
S, schist. J, jaspilite fragments. QQ, quartz veins.
Qu, quartz. JQ, jaspery quartz.

Some of these fragments are pure white quartz, and from them proceed veins of quartz across the bedding planes of the sericitoid. These quartzose, vein-generating masses may be subsequent.

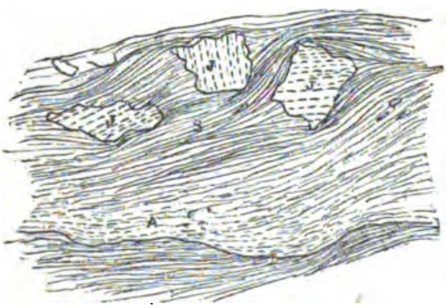

Fig. 5. Sericitic Schist and Inclosures, Half 4.
S. schist J, jaspilite.

Figs. 4 and 5 show the fragments of jaspilyte with their own original bedding. Fig. 6 is a diagram of a jaspilyte breccia, like the other figures, made on the spot. The dotted material is an olive green sericite schist filling the interstices. The original

bedding of the fragments will be noticed here also. The lamination of the schist in Figs. 4 and 5 exhibits a bending and adaptation to the fragments of the jaspilyte. Evidently the fragments were introduced while the layers of schist were forming. The fragments of jaspilyte, as shown in all the figures, were broken from some pre-existing formation, where they had already received their banded structure. They had not been far transported, for their edges and angles are yet sharp. At A in Fig. 5 is a region where the schist graduates into quartz. From this it appears that some quartz was forming contemporaneously with the schist. At JQ Fig. 4, is a fragment of jaspery quartz showing that something jaspery has characters also similar to the contemporaneous quartz. The brecciated regions at this locality are ill-defined varying bands running with the bedding of the schist for limited distances. On each side of the portions figured, the formation is substantially a sericitic schist.

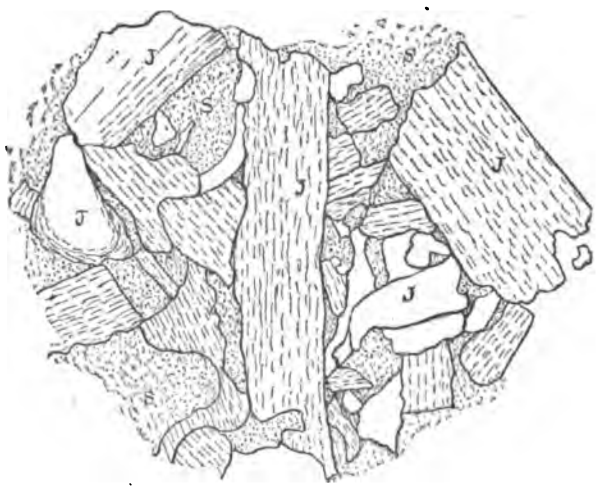

Fig. 6. Relations of Jaspilite and Sericite Schist HALT 4.
J, jaspilite, with broken lines. S. schist, stippled.

HALT 5. S. W. ¼, S. W. ¼, Sec. 21, T. 62-15. Strike N. 60° E.
Rock 8. Sericitic schist.
Rock 9. Sericite schist with quartz grains.
Rock 10. Quartz veins in graywacke schist.

HALT 6. Stuntz' I. N. W. ¼, S. W. ¼, Sec. 21, T. 62-15. The mass of the rock is poroditic conglomerate. Bedding planes

N. 56° E. Beds somewhat sericitic, some layers largely so — others conglomeritic. Included are also plates of black jasper conformable with the bedding.

Crossing the bedding are two sets of dikes — one N. 76° E; the other N. 74° E. dip of beds, S. 82°.

Rock 11. Older system of dikes (so-called).

Rock 12. Later system of dikes (so-called). Sericitic schist with thin white scales of talc(?)

HALT 7. 20 rods north of Halt 6.

Locality of porodyte. Beds strike N. 66° E. Dip 75°.

Rock 13. Porodyte (so-called).

This rock is a massive subgranular felsyte. Texture not granular, but still not uniform. Besides this, delicate interrupted, irregular films of darker matter run in rudely parallel planes through the mass. General color of rock light, with a pale waxy tinge pervading it, weathering nearly white. On the weathered surface of the exposure are wavy, irregular grooves, or seams, which I regard as bedding lines, having the strike indicated above.

From observations made in this vicinity it appears that all these rocks belong to one formation, in a large sense. They are all — graywacke not excepted — pervaded by a magnesian element. In the porodyte we find serpentine masses one, two or more inches long, of a pale greenish color and lamellar structure.

HALT 8. S. W. ¼, S. E. ¼, Sec. 34, T. 62-16. Poroditic felsyte; some parts with grains of quartz. Strike N. 67° E. Dip 82° N.

Rock 14. Poroditic felsyte.

Rock 15. Porphyritically quartzose porodyte, like Rock 13, only few quartz grains.

Rock 16. The so-called quartzyte.

Rock 17. Very dark, schistose, augitic, with feldspar (?) and quartz grains resembling chrysolite, except in color.

The foregoing rocks occur in different beds of this formation.

HALT 9, N. E. ¼, N. W. ¼, Sec. 3, T. 61-16.

Rock 18. Apparently a compact graywacke.

The rock at Halt 9 is compact, very indistinctly bedded, grayish, composed of waxy feldspar and a dark mineral which looks like augite. There are also scattered, glassy grains which have the cleavage, structure and hardness of a plagioclase. This rock, however, is very nearly identical with Rock 1, which is distinctly bedded.

HALT 10. N. E. ¼, N. E. ¼. Sec. 3, T. 61-16. Rock dark, distinctly slaty, lustrous, permeated by a glassy feldspar, which apparently causes the lustre, but occurring also in crystals. Strike N. 79° W. Dip 82°. Glacial striæ S. 23° W.

Rock 19. Graywacke.

The rock at Halt 10 is different from any yet seen. It looks much like a hornblende schist, but there is evidently a large percentage of fine, grayish, feldspathic particles. In fact, I suspect the whole dark constituent is a feldspar (labradorite). There are also disseminated grains like garnets or staurotide, giving the bedding surfaces a pimpled appearance.

Rocks 17 and 18 are embraced in what is provisionally termed graywacke. They are very similar to Rock 1. Rock 3 is similar to these but pervaded by more of a greenish, serpentinoid constituent. Rock 4 resembles Rock 1, but is thin bedded. Rock 18 is little distinguishable from 1.

On the iron mines in this vicinity but few observations were made, and those mostly for comparative purposes.

HALT 63. Stone iron mine. N. W. ¼, S. E. ¼, S. 27, T. 62-15. A ridge of generally schistose character. Beds trending nearly east and west, and standing almost vertical. Consist, before we reach the summit from the north, of banded jaspery iron schists. At the summit they are essentially sericitic, becoming in places a little chloritic, and in others, a little argillitic. The iron ore deposit occupies about 50 feet and has been excavated to depths of 50 to 80 feet. The schists have a dip northward

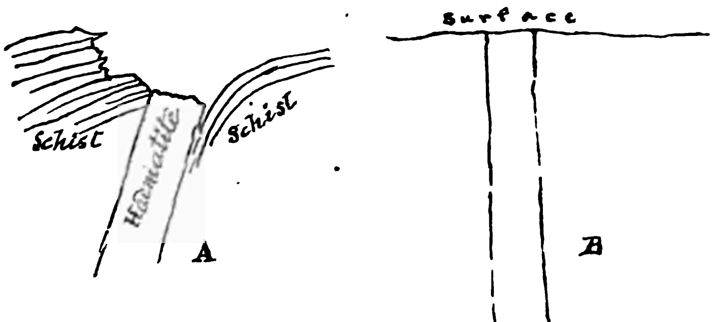

Fig. 7. Views of so-called Dike at Stone Iron Mine. A, Plan on the surface. B. Vertical section on south face of mine.

of about 82°. The south or foot wall is more chloritic and argillitic. The beds are bent, interrupted, crumpled, knotted, smooth-faced.

The structural state of the ore is difficult to ascertain. I judge it from appearances to have bedded arrangement comformable with the schists, but the bedding is certainly less distinct. Some of it is apparently massive. On the south side is an abrupt ledge which has been worked out four or five rods. There are indications here of bedding conformable with that of the formation, but it is not easy to be certain.

In one place, on the south face of the mine, is a southward protrusion of the ore into the schists for a certain distance—how far is not known. This has been pronounced a dike. On the east the schists are bent around toward parallelism with the iron-intrusion. On the other side they are not. On neither side is there anything like a definite wall. The ore and shale and earth blend and intermingle in a way similar to that shown between the main ore and the country rock.

HALT 64. Ely mine, a few rods west of last. An excavation 25 feet deep, and in one part 65 feet. The east side of the deep excavation shows the iron lode divided into three or more parts, like this:

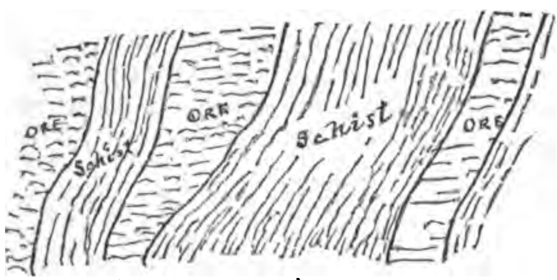

Fig. 8. Dikes so-called in Ely Iron Mine, Town.

These divisions of the lode, I understand, have been regarded as dikes.

The following diagram shows a nearer view of one of the dikes. It appears still further divided by beds of ferruginous schist, a', a'.

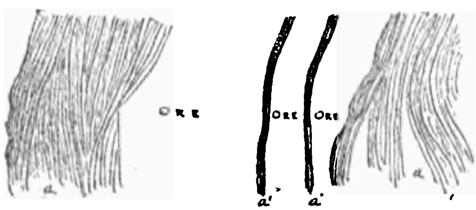

Fig. 9. A nearer view of one of the so-called "dikes."
a a a' a', Ferruginous schist (Red Chalk)
a' a' Still further divisions of the "dikes"

HALT 65. Railroad cut south of Ely mine. This runs along the strike of the sericitic schists; but it exhibits somewhat the nature of the transition from the iron deposits to the schists. In places, that transition is abrupt, and this is seen in the Stone mine; but here we find places where the transition is gradual, either alternating thin layers of jasper and sericite with diminishing amount of jasper, or dissemination of grains of quartz in diminishing abundance through the sericite. These phenomena are not compatible with the doctrine of the dike-like nature of the iron deposit.

HALT 66. Part way down the mountain, on the trail to Stuntz bay. Some magnificent examples of red and black banded jaspery hæmatite. Some of the hæmatite bands are superior ore. Many of them are wonderfully plicated.

HALT 11. S.W. ¼, S.W. ¼, S. 6, T. 62-14. North side of Mud Creek bay, very near the town line. Ridge close by the bay, about 80 feet high, consists of so-called graywacke with many layers slaty, more and less. General hue greenish; sound portion fine grained. Strike E and W. Dip 75°. Quartz veins mostly conformable with bedding.

Rock 20. (From one of thicker beds.) Fine, almost aphanitic, greenish-gray, homogeneous, tough. It is a felsitic schist. Some beds are greenish with a real slaty structure, and might be designated a chloritic slate.

3.—MUD CREEK AND LAKE.

Entering Mud creek from Vermilion lake, we find a stream about six feet deep and less. The water is clear, but filled with *Nuphar lutea* (with another species) and exquisite *Nymphæa odorata.* In N.W. ¼, N. E. ¼, S. 8, a portage of a third of a mile occurs. It is wet and difficult.

HALT 12. N. E. ¼, S. E. ¼, S. 5, T. 62–14. Bench of hill north of Mud creek, opposite east end of portage. Strike N. 60° E., bending to N. 40° E. Dip S. 87°. Chloritic slate, passing into argillyte very thin and slaty. Interbedded with porodyte, porphyritic with feldspar and quartz.

Rock 21. Chloritic sericitic schist.

HALT 13. First foot hill a few rods north of Halt 12, 54 feet above Mud creek. Thinly laminated sericitic schist. Dip 90°.

Rock 22. Sericitic schist — rusty blotches — feldspathic grains.

HALT 14. N. E. ¼, S. E. ¼, S. 5, T. 62-14. Top of hill 200 feet. Strike of beds N. 57° E. Chloritic slates, very irregular in structure — thick and thin-bedded — some graywacke-like in aspect.

Rock 23. Graywacke.

Here are some fragments of jaspery hæmatite. Close by on the north is a solid greenish rock.

HALT 15. Hill 20 rods north of Halt 14. Rock poroditic, with beds of chloritic slate, but mostly with very obscure bedding. Strike N. 50° E. Dip S. 88°. Schistosity N. 30° E.

HALT 16. S. W. ¼, N. W. ¼, S. 3, T. 62–14. At eastern extremity of Little Mud lake. At base of hill. Rock poroditic. A considerable greenish material. Some beds pretty compact, with disseminated grains of quartz, and also grains of pale greenish feldspar — a sort of quartz-porphyry. Other beds a little slaty, with sericitic surfaces. Strike N. 57° E. Dip S. 70°.

Here, twenty years ago, says Charley, our Indian, some adventurers blasted an excavation in the hill-side. I see nothing to allure them except a little yellow pyrites.

Rock 24. Quartzose porphyry.

HALT 17. S. E. ¼, N. W. ¼, S. 3, T. 62-14. South side of Mud lake. Hill rises just back of shore, 80 feet high. A rounded range of quartz porphyry, not essentially different from what has been seen so frequently. Some of the quartz grains are half an inch and over in diameter. I notice here, more than before, their tendency to quadrangular sections. The bedding planes can hardly be detected. The rock is profoundly shattered by joints. It is impossible to get normal specimens. It weathers whitish gray and is very rough. Strike (what seems most like it) N. 79° E. Dip of bedding 78° S. Many of the joints coincide with the bedding; others run N. 42° E. and dip N. 72°.

Rock 25. Quartz porphyry.

Rock 26. Bluish, fine, compact felsite.

Some of the beds of this formation approach a slaty character. There are beds with the same plicated internal structure as seen at Halt 1. Immediately contiguous are hard, bluish, nearly homogeneous beds, breaking in many directions, and resembling a fine trap-like anamesyte.

Rock 27. Anamesyte-like (not anamesyte).

HALT 18. N. W. ¼, N. E. ¼, S. 3, T. 62-15 — or a little over the line in T. 63. Rock similar to Rock 27. Very rugged, dark, yet

in places it appears thin-bedded, and approaches the character of an argillitic, chloritic schist of bluish-green tint.

Rock 28. Anamesyte-looking, like Rock 27.

Rock 29. Chloritic schist, very irregular.

Notwithstanding the bedded spots, I can not find any general trend to the beds. They are short, cuneiform and confused. The rock is similar to the last mentioned, quite at the water's edge.

HALT 19. S. E. ¼, N. E. ¼, S. 3, T. 62-14. Point north side of Mud lake. Rock exactly like that at Halt 17. Strike N. 59° E. to N. 68° E. Dip 90°.

Rock 30. Quartz porphyry, same as Rock 25.

HALT 20. S. E. ¼, S. W. ¼, S. 2, T. 62-14. On portage south of east end of Mud lake. Two ranges of hills about 125 feet high. Rock greenish, chloritic, like that at Halt 19, near the water.

HALT 21. N. W. ¼, S. 12, T. 62-14. On the portage. Slight outcrop.

Rock 31. Compact graywacke.

This portage, so-called, passes over numerous ranges of hills, and is nothing more than a trail. The rocks seen in the hills are greenish, compact and graywacke-like.

4.—SAND LAKE AND VICINITY.

The portage does not touch the little lake between sections 2 and 11. It exceeds two miles in length and winds much. It terminates on a little lake having an island in the centre. This, according to Charley, is lake A-ba-kwa, or Cat-tail lake. There are no outcrops around this island. On the west side is a portage of a third of a mile, which is dry and cut out as if for a wagon road. The lake at its western termination is Nameless. The shores of this lake are without rock exposures. At the southeast angle is a very good portage of about a third of a mile. This takes us to Sand lake, or, as Charley calls it, Mi-da-ung Sa-ka-i-kan.

HALT 23. S. E. ¼, N. W. ¼, S. 13, T. 62–14. Between Nameless and Sand lakes. No distinct outcrops, but many large pieces of jaspery hæmatite and compact gray-wacke.

Rock 32. Jaspery hæmatite.

HALT 24. S. E. ¼, N. W. ¼, S. 13, T. 62–14. East end of Sand lake. Fine sandy beach without rocky outcrops. A few loose bowlders line the shore westward, and a range of hills, 200 feet high, stands a third of a mile back.

HALT 25. N. E. ¼, S. W. ¼, S 14, T. 62–14. Northwest part of Sand lake. Outcrop of a compact, graywacke rock, near the shore—very hard and tough, and full of joints, but much like rocks heretofore seen, at Halt 21 especially. In some of the joints are surface crystallizations of hæmatite. Some portions show obscure mottlings. The weathered aspect of the rock is much like that of a greenstone.

Rock 33. Graywacke. Some portions approaching chloritic schist, but this is the same as heretofore seen.

HALT 26. N. W. ¼, S. W. ¼, S. 14, T. 62–14. A ledge of graywacke rock essentially like last, but with veins of a reddish mineral resembling heulandite, and some disseminated specks. I notice a vein of heulandite (?) a quarter of an inch wide, having a green vein of epidote in the center. The rock contains a good deal of chlorite, and in some joints this becomes conspicuous.

Rock 34. Chloritic, massive graywacke, with veins of heulandite (?) and chlorite.

About eight rods further inland the formation is essentially the same, but contains bands of a mineral having a metallic lustre and looking like jaspery hæmatite, but it gives no red streak—nor black one. In fact, it is as hard as quartz, but too lustrous for a mere jaspery mixture. Contains jasper bands.

Rock 35. Graywacke, compact and massive, with metalliferous bands.

We passed into Armstrong river with a view of reaching Armstrong bay. Soon found fallen trees obstructing the passage. Some of these we cut out, but we soon learned that the stream is not canoeable.

HALT 27. Armstrong River rapids, about one-half mile from the entrance. Here is a disturbed outcrop of black jaspilyte interbedded with greenish chloritic schist. Strike N. 82° W. Dip N. 82°.

Rock 36. Black jasper schist.

Rock 37. Dark chloritic schist, interbedded with the last.

I find in this jasper schist thin bands of the metallic substance seen at Halt 26.

A quarter of a mile further west occur other rapids and narrows. As no distinct trail could be found in the vicinity, it is evident no thoroughfare exists between Sand lake and Armstrong bay. At the southwest angle of Sand lake is a portage.

HALT 28. W. side N. W. ¼, S. 23, T. 62–14. Half way on portage to Eagle Nest lakes. Outcrop of graywacke.

5.—EAGLE NEST LAKES.

These are two very irregular lakes lying in the south eastern part of T. 62–14. Their general trend is northeast and southwest, and they approach within a quarter of a mile of each other. Around the shores of the northern lake is much low ground, but on the southern lake are numerous rocky exposures.

HALT 29. S. W. ¼, N. E. ¼, S. 22, T. 62–14. Northern extremity of North Eagle Nest lake. Outcrop of jasper schists.

HALT 30. S. E. ¼, N. E. ¼, S. 22, T. 62–14. Outcrop of epidotic graywacke mixed with heulandite (?).

Rock 38. Epidotic graywacke with heulandite (?).

HALT 31. N. E. ¼, N. W. ¼, S. 22, T. 62–14. Rock schistose, some parts highly ferruginous.

Rock 39. Ferruginous graywacke. Needle was affected here —turned eastward.

HALT 32. N. E. ¼, N. W. ¼, S. 33, T. 62–14. No outcrops of rock in this vicinity. A few bowlders.

HALT 50. S. W. ¼, N. W. ¼, S. 27, T. 62–14. At isthmus of the peninsula on northwest side of North Eagle Nest lake. Formation graywacke, obscurely bedded, greenish in places with epidote—some epidote veins—some dough-like masses with fibrous bedding in section. Innumerable felsitic veins and disseminated grains, and when the latter weather out, the aspect is amygdaloidal.

Rock 54. Epidotic graywacke schist.

Rock 55. Epidote crystallizing.

I find some calcite imbedded in the rock.

HALT 33. N. E. ¼, S. E. ¼, S. 24, T. 62–14. Small island in South Eagle Nest lake. Sericitic schist with bedded structure distinct. Not so soft as some seen—more compact. Strike N. 70° E. Dip N. 82°. Some beds reddish with red fedspar which, in places, forms the principal mass, and amounts to a felsitic schist.

Rock 39 *bis*. Sericitic schist more compact.

Rock 40. Chloritic sericitic schist.

HALT 34. N. E. ¼, S. E. ¼, S. 26, T. 62–14. Main land opposite Halt 33, north. Rock a compact thick-bedded, sericitic, much-jointed formation. Strike N. 71° W., but obscure and uncertain. Joints N. 8° E.

Rock 41. Compact chloritic sericitic schist.

HALT 35. N. W. ¼, S. W. ¼, S. 25, T. 62–14. Chloritic

schist, dark, soft, distinctly bedded. Strike N. 75° W.—second place N. 84° W. Dip N. 75°.

Rock 42. Chloritic sericitic schist.

Most of this exposure is not especially chloritic. Veins of reddish felsyte exist.

HALT 36. N. E. ¼, N. W. ¼, S. 36, T. 62-14. Main land. Cliff 50 feet high. Chloritic sericitic schist.

HALT 37. N. E. ¼, N. W. ¼, S. 36, T. 62-14. Main land. Cliff 50 feet. Dip N. 80°. Graywacke sericitic schist.

HALT 38. N. W. ¼, N. W. ¼, S. 36, T. 64-14. On large island. Cliff 50 feet. Chloritic graywacke schist, some portions quite fine, compact and hard. Distinctly bedded.

HALT 39. S. W. ¼, N. W. ¼, S. 36, T. 62-14. Rock islet 40 feet long and 20 feet broad, consisting of jaspery schist, dark, banded, hæmatitic. May not be in place.

The needle here is much disturbed. As nearly as I can judge by the sun, the strike of these bands is N. 18° E.

Rock 43. Jaspery ferruginous, sericitic schist.

HALT 40. N. W. ¼, N. W. ¼, S. 36, T. 62-14. Small island. Rock mostly sericitic schist, but with minute, micaceous glistening scales.

Rock 44. Sericitic or damourite schist.

HALT 41. N. W. ¼, N. E. ¼, S. 35, T. 62-14. West point of small island. Graywacke schist.

HALT 42. S. W. ¼, N. E. ¼, S. 35, T. 62-14. Main land. Chloritic sericitic schist.

HALT 43. S. E. ¼, N. W. ¼, S. 35, T. 62-14. Main land. Sericitic schist. Bedding rather distinct. Strike N. 82° E.

HALT 44. S. E. ¼, N. E. ¼, S. 34, T. 62-14. Little island not on plat. Sericitic chloritic schist.

HALT 45. N. E. ¼, S. E. ¼, S. 34, T. 62-14. Main land. Chloritic, sericitic schist.

HALT 46. S. W. ¼, N. E. ¼, S. 34, T. 62-14. Islet not on map. Chloritic sericitic outcrop, with quartz disseminated and in veins. Also some disseminated feldspar and felsitic bands.

Rock 45. Chloritic sericitic schist, with quartz and feldspar.

HALT 47. S. W. ¼, N. E. ¼, S. 34, T. 62-14. Point of main land. Strike N. 89° E. Dip 75° N. Rock still essentially chloritic-sericitic, with parts inclining to graywacke. Intersected by small quartz veins and by veins of felsyte—some felsyte veins having quartz veins along the middle.

Much of the rock is soft, greenish and chloritic. The weath-

ered surfaces are rough, with projecting quartz grains. In places the quartz veins are like threads, forming a net-work. These veins have no determinate direction.

Portions of the rock are a greenish felsyte, but these are neither in beds nor veins. They are very fine and aphanitic. Some of the felsyte portions are porphyritic with feldspar.

It contains amorphous masses of quartz, 10 inches by 15, including smaller masses of feldspar.

Rock 46. Sericitic schist, soft portion.

Rock 47. Petrosilex and felsyte bedded.

HALT 48, N. E. ¼, N. W. ¼, S. 34, T. 62-14. Point of main land marked "Quartz" on plat. Strike N. 83° E. Dip about 75° N.

Outcrop in all respects similar to last, but with the quartzose and felsitic features somewhat stronger, a large part of the rock inclining to be compact and hard.

Rock 48. Sericitic schist, granular, compact.

HALT 49. N. E. ¼, N. E. ¼, S. 34, T. 62-14. Angle of main land. Mining oporations have been carried on here. An eighth of a mile back from here a shaft has been sunk, apparently twenty-five feet at least.

Rock 49. Quartzitic sericitic schist, thick bedded and rusty.

Rock 50. Chloritic, sericitic schist with pyrites.

Rock 51. Sericitic schist thin-laminated.

Rock 52. Quartz vein, ferruginous.

Rock 53. Pyrites in quartz.

The outcrop is not essentially different from many others. The formation is fundamentally sericitic, and planes of bedding can be seen as at other places, but the first rock on the surface is a rusty magnesian rock containing grains mostly blended with the matrix, but reminding one of the poroditic rock, so-called, on Vermillion lake. Some specimens even contain the quartz-like mineral, so much resembling andalusite in form. The weathered surfaces are quite friable, but the sound rock is seen permeated by a red mineral. This is Rock 49. This formation is irregularly intersected by quartzose and feldspathic veins like that at Halt 47. The abandoned shaft is about six to eight feet in diameter, with many tons of rock thrown out. Here we find the most abundant fragments are a chloritic, sericitic schist—Rock 50—containing, frequently, cubes and masses of pyrites disseminated through it. Other portions of the formation are a fine, laminated, translucent, sericite schist, which is intersected by veins of quartz and iron pyrites. This is Rock 51.

Many quartz veins run through the whole formation. Rock 52 is a sample, containing hæmatitic stains, very much indeed as in some argentiferous quartz. Other quartz veins are pervaded by pyrites in abundance, as shown in Rock 53. In some cases a mass half the size of one's head is pure pyrites. The pyrites and quartz are sometimes seen to be intersected by minute, sinuous veins of a dark, lustrous, iridescent mineral resembling "peacock ore" of copper. These are the glittering minerals which sustained, not without some reason, the hopes of the adventurers.

HALT 51. N. W. ¼, S. W. ¼, S. 13, T. 62-14. On the portage from N. Eagle Nest lake west. Felsitic graywacke, epidotic like that at Halt 50. Strike N. 68° W. Glacial striæ 20° S. W.

HALT 52. S. E. cor. N. E. ¼, S. 29, T. 62-14. On the portage. Epidotic graywacke, weathering sericitic in aspect. Strike east and west.

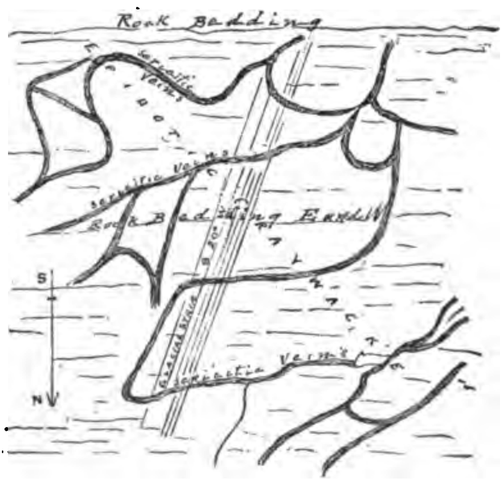

Fig. 10. Veins of sericitic material in a formation of epidotic graywacke, at Halt 52.

This smooth-topped exposure is curiously marked by veins of a sericitic material similar to portions—especially weathered portions—of the country rock. The formation is seen stretching along to the north of the east point of the little lake in section 29.

HALT 53. N. E. ¼, S. E. ¼, S. 29, T. 62-14. East end of little lake—Gem lake. Graywacke, more chloritic than epidotic.

HALT 54. S. W. ¼, N. E. ¼, S. 29, T. 62-14. North side of Gem lake. General aspect of rock slaty-blue and distinctly bedded. It might be called compact chloritic slate; but it retains a graywacke aspect, showing that the formation is fundamentally the same. Here, also, is a set of reticulating sericitic veins, like those at Halt 52—but these are slaty blue. *The bedding lines continue their course across these veins.* This indicates that the bedding lines are superinduced in the formation, and not sedimentary planes. Strike N. 89° E. Joints N. 30° E. Same rock continues west to near portage.

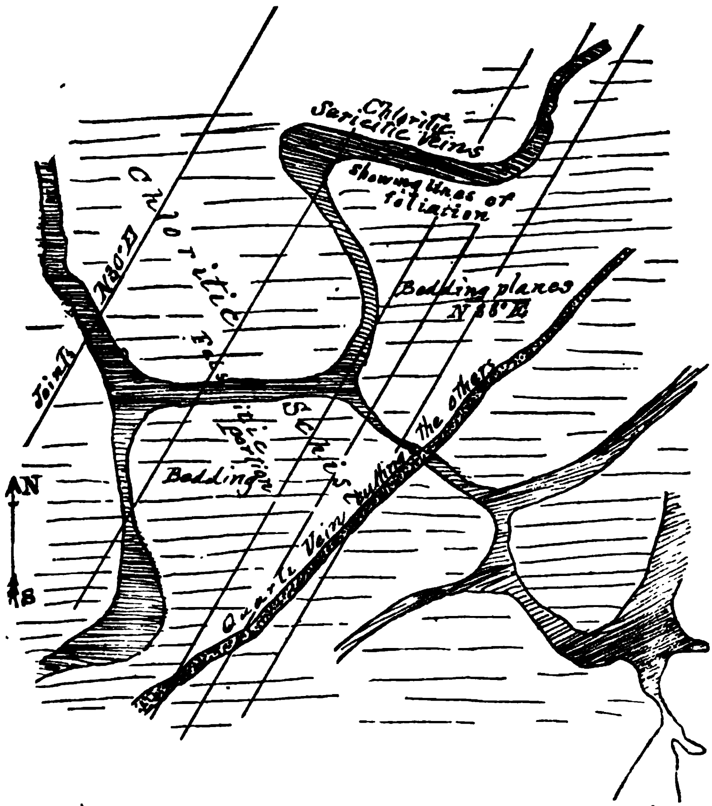

Fig. 11. Reticulating Veins of Sericitic material at Halt 54.
Horizontal Surface.

HALT 55. S. E. ¼, N. W. ¼, S. 29, T. 62-14. S. W. side of Gem lake. Rock exactly like that at Halt 54.

Rock 56. Chloritic schist, heavy-bedded.

Rock 57. Chloritic schist forming a vein.

Strike of beds E. and W. *Lines of structure in the veins here incline to run parallel with the walls of the veins.*

HALT 56. Centre of N. W. ¼, S. 29, T. 62-14. On little lake at portage northwest—Gem Lake. · Outcrop exactly like Halts 54 and 55. These chloritic schists are not characteristic schists, but approach metamorphic conditions, having a striking external resemblance to diabasic rocks. They are cut up with joints, and the bedding is very irregular.

The structure of the veins follows their direction.

A blind trail leads from here to Saddlebags lake—the next little lake to the northwest.

HALT 57. N. W. ¼, N. W. ¼, S. 29, T. 62-14. S. E. side of Saddlebags lake. Only a few drift bowlders are seen here.

HALT 58. S. W. cor. S. 20, T. 62-14. E. side of Saddlebags lake. Outcrop of chloritic graywacke.

HALT 59. N. W. ¼, S. W. ¼, S. 20, T. 62-14. N. E. point of lake. Graywacke, barely outcropping. A few rods back, the rock approaches a gabbro.

HALT 60. N. ¼, S. E. ¼, S. 19, T. 62-14. N. E. shore of the lake. No outcrop, but we find a bark shelter recently occupied. Ascended a hill to the north, but found no outcrop. Turned south around the swampy point but found nothing. At the shelter picked up a fragment appearing to contain lamellar labradorite—in fact consisting chiefly of it, but it is rather soft.

Rock 58. Labradorite (?) chiefly.

Found also some loose fragments of banded hæmatitic jasper, too hard to give a streak.

Rock 59. Ferruginous jasper, as above.

HALT 61. N. W. ¼, S. W. ¼, S. 19, T. 62-14. Commencement of portage to Armstrong bay—16 rods. Graywacke schist, vertical—8 rods farther, iron jasper schist—16 rods farther. ferruginous slate—16 rods beyond, banded iron jasper schist, elevation about 200 feet—20 rods farther, a valley—20 rods beyond, jasper on a hill about two hundred feet high, 16 rods still farther, jasper iron schist. Needle much disturbed. Thirty rods beyond, red and black iron schist—16 rods, chloritic graywacke schist. Here is a little cool creek running west.

HALT 62. N. W. ¼, N. E. ¼, S. 19, T. 62-14. Hill on portage, 200 feet high. Large outcrop of quartz porphyry.

Rock 60. Quartz porphyry.

This is succeeded abruptly, on the north, by jasper schists

dipping N. 82°, 20 rods—followed by porphyry again, 20 rods. Then jasper schist, brecciated and quartzose, with a matrix of quartzose porphyry, twenty rods, then a feeble exposure of mottled felsyte, 30 rods, then, finally, quartzose porphyry. Nothing more outcrops for 50 rods, to the end of the portage. The distances, of course, are simply estimated.

We may now write in order, the rocks observed southward from Armstrong's bay:

No rock observed in place	16	rods
Quartzose porphyry	25	"
Mottled felsyte—small exposure	30	"
Jasper schist, brecciated and quartzose	24	"
Quartz porphyry (200 feet)	25	"
Jasper schist, dipping N. 82° E	25	"
Quartz porphyry	12	"
Valley and little stream	12	"
	—169	"
Chloritic graywacke schist	16	"
Red and black jasper iron schists	30	"
Jasper iron schist. Needle disturbed	16	"
Iron jasper (200 feet)	20	"
Valley	20	"
Banded iron jasper schist (200 feet)	16	"
Iron slates	16	"
Iron jasper	8	"
Graywacke schist, vertical	16	"
Total, 5,300 feet	327	rods

The whole section of 5,200 feet, in a straight line, is divisible into a quartzose porphyry series of about 2,700 feet and a jaspery series of 2,600 feet.

6. BURNTSIDE LAKE.

This noble and beautiful lake, called by the Indians Ga-na-ba-ne-ia-bi-gi-teia-ga-mak, stretches diagonally across township 63-13. It extends about a mile into range 14, and a mile and a half into range 12. A northern arm not less than three miles long, reaches into township 64; but neither this township nor the one on the west has yet been surveyed, and the locations of halts within them are yet conjectural. Into a northern arm of the lake empties a deep, clear and boatable stream, which issues from three small lakes, the largest of which, Pretty lake, is over a mile long, and extends into township 64. The whole length of

Burntside lake is about eight and one-half miles, and its mean breadth about one and one-half miles. Its shores are mostly rocky and elevated, but not inaccessible. Hundreds of rocky islands diversify its surface and constitute quite a labyrinth. The original forest has mostly disappeared by burning, though Norway pine of fair quality occurs in patches along the south shore; and white and Norway pines of fine growth occur upon the shores of the little lakes and the deep bay upon the northern border. The thin soil is in possession of great quantities of blueberry and raspberry bushes, which, in their season, furnish a grateful supply of food, while at all times, the scarlet wintergreen berries supply a garnish to the dun aspect of the surface. The lake abounds in excellent pickerel and pike, and it is said the white fish, as in Vermilion lake, is sometimes caught. Some day, the pleasure-seeker will discover the charms of Burntside lake to exceed those even of the "Thousand Islands" in the St. Lawrence.

Opportunities for geological study are unsurpassed. The primitive mossy covering has been removed from the rocky exposures by fire, and whole acres of rocky beds lie with their upturned edges ready for the geologist to trace their succession across thousands of feet, and note the methods of transition from formation to formation. Here in fact, is the most instructive geology in the Northwest. Careful studies were made upon all sides of the lake and on scores of the islands.

Only the western portion of the north shore of the lake remains unstudied.

The route proceeds from the eastern extremity of Mud lake over the usual portage and thence along the western and southern shores to the eastern extremity, excursions being made to several of the islands on the way. From the eastern extremity the route returns over the north shore and the contiguous islands on the one hand, and lakes on the other to section 16, where the survey was interrupted.

HALT 68. About one-fourth mile on portage. Outcrop of graywacke.

The portage embraces a broad, wet swamp; but half the portage is dry. The swamp lies between two ranges of hills.

HALT 69. Sec. 25 (supposed) T. 63-14. Near end of portage, on creek flowing into Burnside lake. Outcrop of micaceous schists. Strike N. 59° E. Dip N. 60°. These schists consist apparently of biotite, muscovite and quartz. The mica scales are

fine. The muscovite is light gray and looks sericitic, but the scales are bright. The formation is intersected by veins of biotite granite belonging to two systems, as shown below.

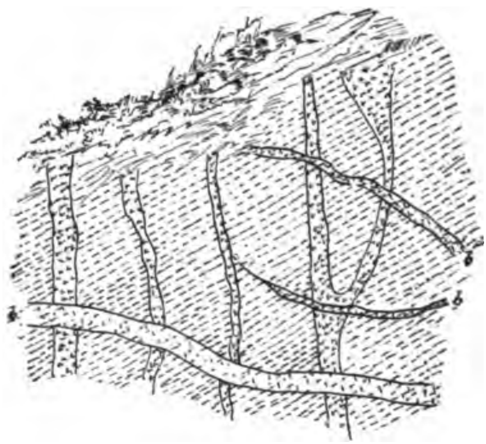

Fig. 12 Granitic Veins in muscovite-biotite schist at Halt 69, near Burntside Lake, Vertical Face of cliff
b b Granite with little mica.

From this point a fine and navigable creek, six feet deep and and twenty-five feet wide, flows into Burnside lake.

HALT 70. S. 25? T. 63-14. On creek three-fourths mile beyond portage. Mica schist exactly like that at Halt 69. It rises in a high, broken front with granite veins as in the other locality.

HALT 71. Sec. 36? T. 63-14. About 1½ miles beyond the portage. A wall of massive mica schist comes down to the water, having two sets of granite veins as at Halt 69.

Rock, 61. Compact graywacke mica schist.

Rock 62. Granite vein.

HALT 72. One-fourth mile from Burntside lake. North side of creek. Graywacke mica schist, with a net work of granulyte veins.

HALT 73. On the opposite side, at the entrance to the lake, a bold promontory of mica schist intersected by granitic veins. Similar bold bluffs continue along the west end of the lake. Dip N. 60°.

At one place is a granitic intrusion about forty feet wide. Consists of rather fine-grained, reddish feldspar and quartz, with many large grains of free quartz.

Further along (west end) the mica schist is very fine and compact, and still contains veins of granite. Same continues to N. W. corner of lake.

HALT 74. South shore, near the S. W. corner of the lake. Very fine and compact micaceous rock.

HALT 75. N. W. ¼, S. W. ¼, S. 32, T. 63-13. Base of point south shore of Burntside lake. Very fine grained mica schist, bluish and hard, and having granitic veins.

Rock 63. Graywacke mica schist.

Rock 64. Very fine compact mica schist.

HALT 77. S. W. ¼, N. W. ¼, S. 32, T. 63-13. On the point. Mica schist. Strike N. 58° E.

Rock 65. Mica schist.

HALT 78. Near centre of section 32, T. 63-13. Well marked mica schist distinctly laminated and fine-grained. Dip S. 60°.

Rock 66. Mica schist.

HALT 79. N. W. ¼, N. E. ¼, S. 32, T. 63-13. At extremity of point. Mica schist with granitic dikes. Strike N. 71° E. to N. 78° E. Dip S. 60°.

HALT 80. N. E. ¼, S. E. ¼, Sec. 29, T. 63-13. Mica schist, fine, compact, but slaty and argillitic. Strike N. 70° E.

Rock 67. Argillitic mica schist.

HALT 81. S. W. ¼, N. W. ¼, S. 28, T. 63-13. Fine mica schist. Strike N. 69° E. Dip S. 63°. Glacial striæ S. 19° W.

HALT 82. S. W. ¼, S. W. ¼, S. 21, T. 63-13. Mica schist, characteristic. Would make good scythe-stones and good flagging. Breaks spontaneously into good shapes.

Rock 68. Mica schist, characteristic.

HALT 83. S. W. ¼, S. E. ¼, S. 21, T. 63-13. Nothing but light drift.

HALT 84. N. E. ¼, S. E. ¼, S. 21, T. 63-13. South point of large island. A very rocky shore with angles and isolated crags giving a most rugged aspect. Formation fundamentally a fine-grained but distinctly laminated schist. Strike N. 67° E. Dip 82°. Extensively intersected by granite intrusions. The general tendency of these is to conformability with the bedding; but they split and swell and branch in every conceivable manner. Here is one example.

The granite is mostly with very little mica. The swellings and some of the small connections are coarse granulyte in which

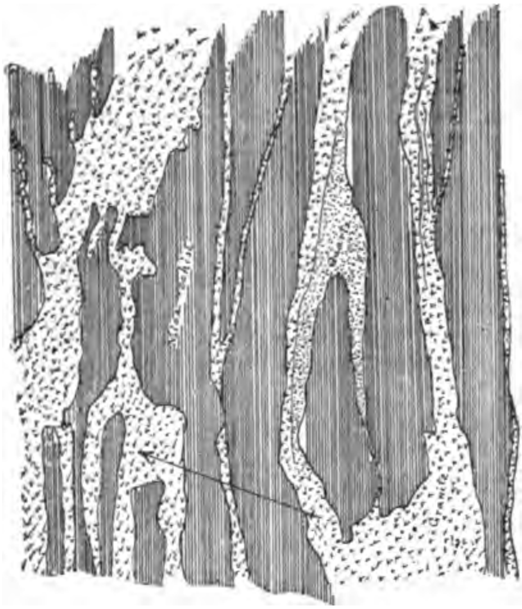

Fig. 18. Relations of Mica Schist and Granite at Halt 84, Burntside Lake. Surface 12 feet square

the quartz is very conspicuous and sometimes almost entirely displaces the orthoclase.

HALT 85. S. W. ¼, N. E. ¼, S. 21, T. 63-13. Enormous abutment of mica schist so cut up with intruded granite that half the mass is granitic.

HALT 86. N. W. ¼, N. E. ¼, S. 21, T. 63-13. N. W. point of same large island. Formation largely taken up with intruded granite. *A most interesting exhibition.* There is a distinct tendency of the granite to conform with the bedding, but it is nowhere exact. It lies in some places in great masses. It is of two kinds; one with reddish orthoclase and the other with whitish; but these do not appear to belong to two systems of injection. In the former, the feldspar much exceeds the quartz. In neither is mica conspicuous, even when present.

Notwithstanding the abundance of granite, the mica schist is everywhere distinctly laminated.

The granite and schist are mingled not only through abundance of granite injections, but by much interpenetration on a small scale. Portions of the rock are so ribboned with granitic and schistose ingredients irregularly succeeding each other, that the rock is literally schisto-granitic.

The appearance of this region indicates a gradual passage from mica schist into granite — not mineralogically, but structurally.

The bedding of the schists is often locally bent by the granite. Strike of beds N. 82° E.

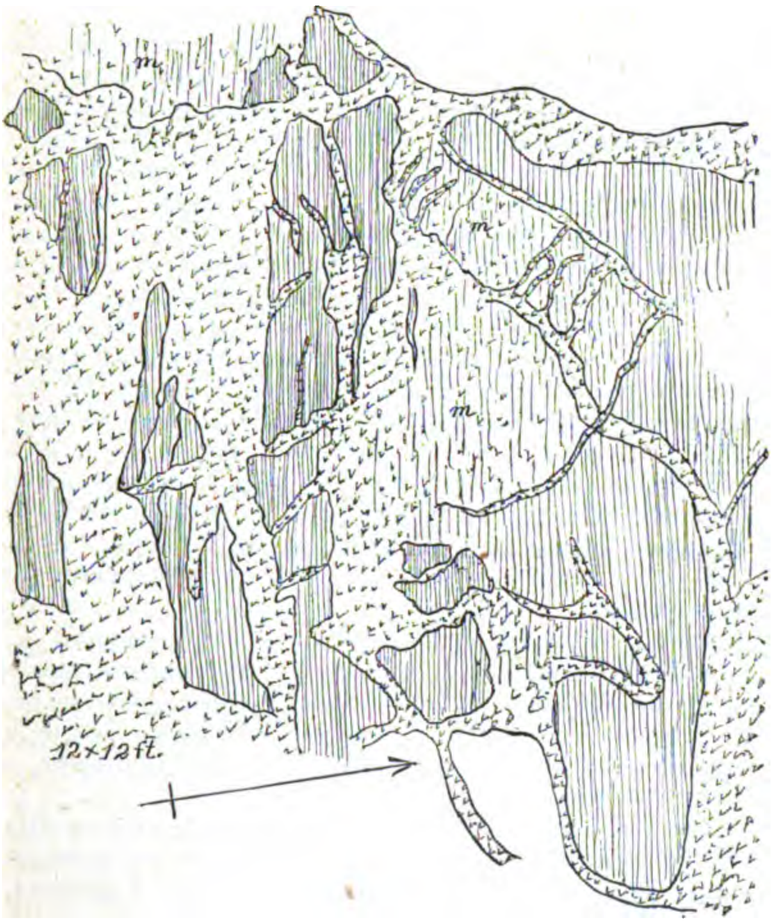

Fig. 14. Relations of muscovite schist and granite, Halt 86, Burnside Lake, In the regions marked m the schist and granite are intimately mixed.

HALT 87. N. E. ¼, N. E. ¼, S. 21, T. 63-13. Northwesterly point of island. All a mass of mica schist permeated by granite. Dip vertical.

HALT 88. S. W. ¼, N. W. ¼, S. 22, T. 63-13. On the island. Mica schist with north dip of about 87°.

HALT 89. S. W. ¼, S. W. ¼, S. 23, T. 63-13. Main land. Boss of rock 100 feet high. Fundamentally fine, compact mica schist; in places having hundreds of veins of epidote traversing it, conformably with the bedding; also many veins of quartz similarly conformable, and others crossing the beds. Also veins of epidote across the bedding. Strike N. 63° W. Dip 66° S.

HALT 90. N. W. ¼, S. W. ¼, S. 23, T. 63-13. Rounded point of main land. A mass of granite. Considerable search is required to discover any schist whatever. The principal mass of the granite is a medium-grained biotite granite. This is intersected by two systems of granitic veins — one of which is fine-grained, with little mica, and the other a granulyte. The feldspar in all is light colored, and there is also some muscovite.

Of mica schist the only example found is about two feet wide. It is fine-grained, compact, brittle. It forms on two sides a sharp junction with the granite, but is in places penetrated by granitic intrusions. It approaches the character of a fine gneiss. I have traced this bed of schist about 60 feet, in a direction N. 71° E.

A hill rises in the rear, 75 feet high, but is covered by drift.

HALT 91. Centre of S. W. ¼, S. 23, T. 63-13. Great mass of hornblende schist, with considerable feldspar, intersected by quartzose veins mostly conformable with the bedding. Also by a dike of fine light-colored muscovite granite 2½ feet wide, striking N. 51° E. Strike of the schist, N. 69° E. Dip south but nearly vertical.

Adjoining this on the south the rock assumes the character of a syenitic gneiss, with much hornblende. This gneissic mass is extensively intersected by veins which are either quartzose, felsitic or epidotic — sometimes a felsitic vein being split by a quartzose one. The gneissic mass — so called — is properly a very massive hornblende schist.

In this part is a granite vein, nine inches wide, running with the strike, and having itself, on the weathered surface, structure lines parallel with the bedding planes of the schist. This vein is faulted twelve inches, and terminates abruptly in its eastward extension. It is not a proper granite, but a compact, fine-grained gneiss.

Rock 69. Hornblende schist, very massive.

Rock 70. Dike in the hornblende schist.

HALT 92. Centre of S. W. ¼ of S. 23, T. 63-13. Mica schist intersected by many veins of granite, granulyte and quartz. This is the whetstone rock, again, of Halt 82. Strike N. 86° E. Dip 50° S. near shore, 83° on the hill.

Embraced in the mica schist is a mass of light-colored granulyte surrounded by the schist on all sides, and embracing fragments of the schist, which still retain their laminated structure and their original position. See Fig. 15.

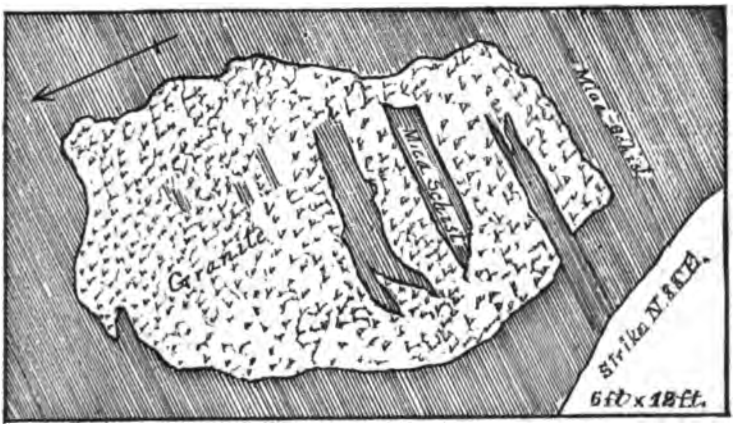

Fig. 15. Schist inclosing Granulite, itself embedding Mica Schist, Halt 92, Burntside Lake.

The granulyte contains also a layer of muscovitic hornblende schist.

HALT 93. N. W. ¼, S. E. ¼, S. 23, T. 63-13. Mica schist. Strike N. 60° E.

HALT 94. S. W. ¼, N. W. ¼, S. 24, T. 63-13. Mica schist, very distinctly thin bedded, but solid and ringing.

HALT 95. N. E. ¼, N. W. ¼, S. 24, T. 63-13. Boss of hydromica granite, but with hornblendic mica schist joining abruptly on the south.

Rock 71. Hydromica granite.

HALT 96. S. E. ¼, S. W. ¼, S. 13, T. 63-13. On island. Hydromica granite with coarse grains of quartz and white feldspar. Intersected by pinkish veins of vitreous granite without mica.

HALT 97. N. E. ¼, N. W. ¼, S. 24, T. 63-13. Main land opposite island. Hydromica granite exactly like last.

HALT 98. N. E. ¼, S. E. ¼, S. 13, T. 63-13. Hydromica granite.

HALT 99. N. W. ¼, N. E. ¼, S. 18, T. 63-12. Point of main land. Mass of granite through which pass beds of hornblende schist, having strike N. 78° E. One of these beds is 3 feet wide and can be traced 30 feet, when it disappears under the soil.

Rock 72. Granite from Halt 99.

Rock 73. Hornblende schist in bed embraced in granite.

HALT 100. N. E. ¼, N. E. ¼, S. 18, T. 63-12. Granite, but with inclusions of dike matter.

Rock 75. (See 74 at Halt 106.) Dike, at Halt 100.

HALT 101. S. E. ¼, N. E. ¼, S. 18, T. 63-12. Biotite granite, medium grained.

HALT 102. Island near east end of Burntside lake. Granite of light color exteriorly, intersected by veins of reddish granulyte. Here, also, is another bed of hornblendic matter appearing like a dike, and having some resemblance to a fine dioryte.

HALT 103. Near centre of S. 8, T. 63-12. Granite. Fundamentally hydromica granite of light color, but extensively intersected by dike-like beds of dioryte-like hornblende schist, and including some black chunks of fibrous hornblende schist.

This sort of granite continues southwestward along the lake shore.

HALT 104. North side S. 18, T. 63-12. Granite with many large quartz grains.

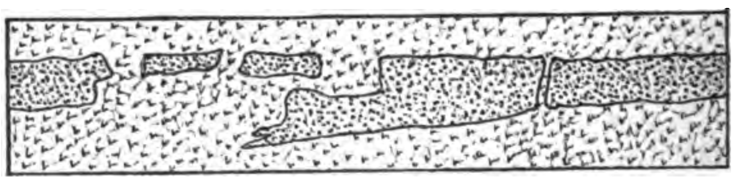

Fig. 16. Broken, dike-like form in Granite. Halt 104. Burntside Lake.

This is intersected by a dike-like intrusion of dark color, fine grain, appearing to be made up of hornblende and a feldspar, and having a very dioryte-like look. Still, these intrusions have reached this igneous aspect by so obvious a gradation from hornblende and mica schist, that one is led to believe the matter was once simple schist, then softened, altered and squeezed into fissures.

HALT 105. N. W. ¼, N. W. ¼, S. 18, T. 63-12. Extremity

of point or near it. At water's edge rock is largely fine dioryte, but on the hill it is the usual granite.

HALT 106. Twenty rods from S. end of island. Dioryte, coarse, containing black, lustrous hornblende and a pink feldspar. A handsome rock, suitable for fine architecture and monuments.

Rock 74. See 75, Halt 100. Dioryte (or hyposyenyte.)

HALT 352. N. W. ¼, N. W. ¼, S. 13, T. 63-13. Large island. Hydromica granite, medium grained.

HALT 351. S. E. ¼, S. E. ¼, Sec. 14, T. 63-13. Small island. Hydromica granite.

HALT 353. N. W. ¼, S. W. ¼, S. 13, T. 63-13. Small island. Hydromica granite with coarse, disseminated grains of quartz. In places these grains are one-fourth inch in diameter, and the reddish orthoclase is still coarser.

HALT 354. S. W. ¼, N. W. ¼, S. 13, T. 63-13. Small island. Hydromica granite and muscovite granite. At one place I observed a patch in which hornblende was the dark mineral. We still have coarse, disseminated quartz.

HALT 355. N. E. ¼, N. E. ¼, S. 13, T. 63-13. Mostly a hydromica granite, with coarse, disseminated grains of quartz. The longer dimensions of these grains lie in a direction N. 60° E. The rock is intersected by numerous veins of granulyte with reddish orthoclase. In some detached masses of granulyte, which I think are nearly in place, I find portions with reddish feldspar, portions with white feldspar, and other portions extraordinarily coarse. I see included, also, rounded masses of hornblende schist.

HALT 356. N. E. ¼, N. E. ¼, S. 13, T. 63-14. The principal rock is a biotite granite, but it is intersected by a dike of dioryte, which itself incloses many angular and rounded fragments of granulyte, and is also intersected by dikes of granulyte.

Rock 156. Biotite granite, somewhat hydromicaceous.

HALT 357. N. E. ¼, N. E. ¼, S. 13, T. 63-13. Mass of granulyte, very variable in texture, and presenting still further varieties in its veins and dikes. As exposed on the shore in a nearly vertical wall, it has the appearance of the ordinary bedded schists dipping N. at an angle of 70°. This illusory appearance is due to joints, which, with another set making an angle of 75° or 80° with these give the formation a columnar structure.

Rock 157. Hydromica granite from a portion of the above mass. This is a piece of a quadrangular prism.

I find a boulder here of a very remarkable character. It is a mass of quadrangular crystals of feldspar which unweathered are bluish, but on weathering assume a slightly pinkish tint. These are imbedded in a matrix of dark greenish matter, which, I think, must be essentially augite. The rock must be either diabase or noryte.

Rock 158. Noryte, as above.

HALT 358. N. E. ¼, N. E. ¼, S. 13, T. 63-13. Biotite granite. Intersected by veins of granulyte.

HALT 359. N. E. ¼, N. E. ¼, S. 13, T. 63-13. Medium-grained biotite granite. Contains a dike of fine dioryte fifteen inches wide and dipping N. 23°. The dike varies to coarser dioryte and is intersected by veins and dikes of granite. The dioryte contains a very large proportion of hornblende.

HALT 360. S. W. ¼, S. E. ¼, S. 12, T. 63-13. The rock at the beach is granite, varying from white to reddish, and to granulyte. A little back I find a band of dioryte. Then numerous bands, and more numerous as I proceed north, until the formation is two-thirds dioryte and one-third granite. The dioryte bands are substantially parallel with each other and strike N. E. Examining this bedded dioryte with a lens, I find no quartz and no mica; but further from the shore I see minute glistening specks which give a suspicion of mica, but nothing more.

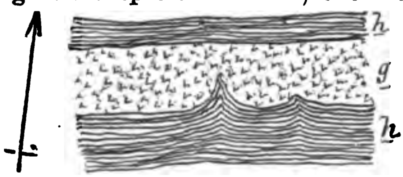

Fig. 17. Relation of granite and hornblende schist, at Halt 360, Barntside Lake.

Rock 159. Granite.

Rock 160. Interbedded granite and dioryte.

Rock 161. Bedded dioryte.

At the distance of three hundred feet back from the shore (northward), the dioryte has developed a few small grains and laminæ of quartz which displaces part of the feldspar; and there are now present obvious laminæ of biotite, with a suspicion of muscovite.

The dark rock is now essentially a micaceous hornblende schist. It is interbedded with granulyte and strikes N. 80° E.

Rock 162. Micaceous hornblende schist.

In its contact with granite beds it adapts itself to the inequalities of the granite, as shown in figure 17. At some points the granite itself is a biotite gneiss.

I find, also, characteristic coarse-grained dioryte, but whether in dikes intersecting the bedding of the formation, or in conformable beds, I could not ascertain.

The formation has now become somewhat nondescript, consisting of perhaps one-fourth interbedded granite, nearly three-fourths slightly micaceous hornblende schist, and the remainder of syenitic gneiss and granular dioryte. In this mixed state it trends N. E. and forms a rocky range on the north side of the bay, attaining an altitude of fifty feet.

HALT 361. S. E. ¼, S. W. ¼, S. 12, T. 63-13. Here we see there markable structural features shown in Fig. 17. The formation is about half granite and half mica schist. The diagram shows the mode of transition. The rocky materials are more confused than at Halt 360.

Fig. 18. View of remarkable rock-structure at Halt 361, Burntside Lake.

a. Reddish compact granulyte with a little muscovite.
b. Whitish granite with abundance of biotite.
c. Whitish biotite-granite.

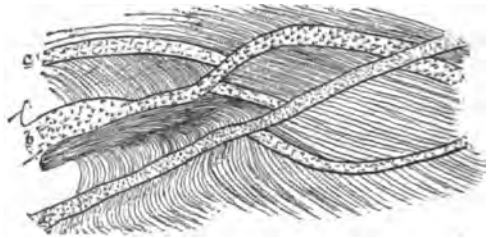

Fig. 39. Consecutive veins at Halt 361, Burntside Lake.
a. Reddish compact granulite with a little muscovite.
b. Whitish granite with abundance of biotite.
c. Whitish biotite granite.

A little back, the formation embraces a vein which looks much like a mass of diallage. It contains also a little mica.

Rock 163. Diallage (?) from a vein as above.

HALT 362. S. W. ¼, S. W. ¼, S. 12, T. 63-13. Granite and schist mixed, but with preponderance of granite.

HALT 363. S. E. ¼, S. W. ¼, S. 12, T. 63-13. Granite and mica schist mixed as before. The schist is fully three-fourths of the whole.

HALT 364. Centre S. W. ¼, S. 12, T. 63-13. Mica schist with much granite mixed in the form of veins and dikes.

HALT 365. N. E. ¼, S. W. ¼, S. 12, T. 63-13. More than half granite. The mica schist is variously interbedded as before. Also dioryte and syenite.

Rock 164. Granite with green feldspar. An enormous bluff sixty feet high.

HALT 366. N. E. ¼, S. E. ¼, S. 12, T. 63-13. Granite and mica schist.

HALT 367. N. E. ¼, S. W. ¼, S. 12, T. 63-13. Granite and mica schist.

HALT 368. S. W. ¼, S. W. ¼, S. 12, T. 63-13. Mica schist and granite — the former predominating. The schist is mostly very hard and very fine, but it is genuine.

HALT 369. S. W. ¼, S. W. ¼, S. 12, T. 63-13. Mica schist and granite with preponderance of schist. Here lies a detached mass on the top of a bluff, 12 feet high, 15 feet long and 11½ feet wide.

HALT 370. N. W. ¼, S. W. ¼, S. 12, T. 63-13. Granite and

mica schist — the granite ranging from one-fourth to two-thirds of the whole mass — varying with locality. Contains veins of epidote as a constituent in certain places.

HALT 371. N. E. ¼, S. E. ¼, S. 11, T. 63-13. In the stream entering from north. Granite and mica schist.

HALT 372. N. E. ¼, N. E. ¼, S.11, T. 63-13. All granite, with feldspar ranging from reddish to white. I find, however, some dioryte schist interbedded.

HALT 373. N. W. ¼, N. W. ¼, S. 12, T. 63-13. Mostly granite, but with included masses of dioryte schist and micaceous schist. (For dioryte specimen see Rock 168.)

HALT 374. N. W. ¼, corner S. 12, T. 63-13. On creek. Could not land, but could see that the rock consists of granite and a dark bedded material.

HALT 375. N. W. ¼, N. W. ¼, S. 12, T. 63-13. Granite, all interbedded with biotite schist quite dioryte-looking on the weathered surface.

HALT 376. S. W. ¼, S. W. ¼, S. 1, T. 63-13. Granite and a dark rock which I guess to be mica schist, since I could not get to it.

HALT 377. S. E. ¼, S. W. ¼, S. 1, T. 63-13. Granite and mica schist about equal.

HALT 378. N. E. ¼, S. W. ¼, S. 1, T. 63-13. Entrance to Pretty lake. Gneiss of two varieties, interbedded with graywacke mica schist.

HALT 379. Near centre of S. 1, T. 63-13. Mica schist and granite as 3 to 1. The schist biotitic.

HALT 380. Near centre of S. 1, T. 63-13. Mica schist and granite interbedded, about 3 to 2. Large exposure.

HALT 381. N. E. ¼, S. 1, T 63-13. Mica schist mostly, but also granite and beds appearing like a mixture of biotite and augite.

Rock 165. Mixture of biotite and augite?

HALT 382. S. E. ¼, S. 36, T. 64-13. Mostly biotite schist, very compact and apparently diallagic.

Rock 166. Diallagic biotite schist (?)

HALT 383. S. E. ¼, S. 36, T. 64-13. Near extremity of Pretty lake. Rock largely gneissic, but with much mica schist. Here is a detached mass, hardly a boulder—35 feet by 21 feet by 15½ feet.

HALT 384. S. 36, T. 64-13. Extremity of Pretty lake. Mostly granite.

HALT 385. About on township line. Granulyte (coarse) and granite amazingly intermixed with a schist containing biotite and lamellar hornblende.

Rock 167. Schist from Halt 385.

Rock 168. Dioryte from Halt 373.

HALT 386. N. W. ¼, N. W. ¼, S. 23, T. 63-13. Island. Hydromica granite and nothing more.

HALT 387. S. W. ¼, S. W. ¼, S. 14, T. 63-13. Hydromica granite with some intermixture of mica schist. But the schist is not one-twentieth the whole mass. Schist fine and biotitic.

HALT 388. S. W. ¼, S. W. ¼, S. 14, T. 63-13. Granite mixed with typical mica schist and similar beds of dioryte schist about one-fourth. Some extensive beds are made of mica schist for a basis, but with imbedded lenticular lumps of a black color which are either hornblende or augite—also quartz sergegations and intersecting veins of granulyte.

Rock 169. Masses of hornblende as above.

HALT 389. S. part of N. E. ¼, S. 14, T. 63-13. Beds of granite and mica schist dipping conformably N. 75°.

HALT 390. N. E. ¼, N. E. ¼, S. 14, T. 63-13. Beds of granite and schist dipping N. 80°.

HALT 391. Near centre of S. 14, T. 63-13. *A remarkable exposure* 50 feet high, more than half schist, interbedded with granite.

Rock 177. Mica schist and granulyte interbedded—a most inadequate representation.

Here are some of the most convoluted veins yet seen, and I make a literal drawing of one in Fig. 20. The formation includes also chunks of dioryte and of augite rock. There ought to be half a dozen photograpic views taken.

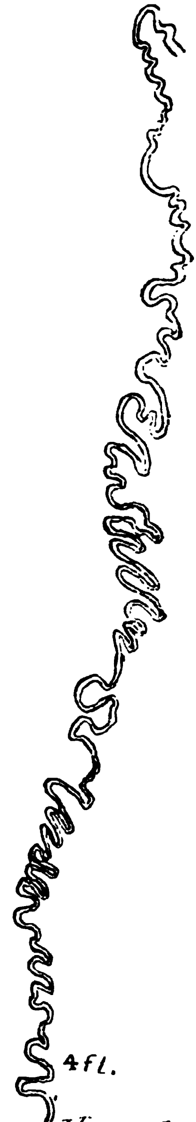

Fig. 20. Vein of granulite at Halt 391, Burntside Lake. Continues 15 feet.

HALT 392. S. W. ¼, N. W. ¼, S. 14, T. 63-13. Mica schist and granite interbedded and intertwisted. Over half schist. Contains, also, masses of dioryte.

HALT 393. N. E. ¼, S. 15, T. 63-13. Granite and mica schist in proportion of two to three.

HALT 394. N. E. ¼, N. W. ¼, S. 15, T. 63-13. Mica schist, extensively intersected by veins of granite.

HALT 395. S. W. ¼, S. W. ¼, S. 10, T. 63-13. Mica schist extensively veined with granite. Some of the schist is hornblendic. Some dioritic schist is here.

HALT 396. Near centre S. 10, T. 63-13. Mica schist and granite as 4 to 1.

HALT 397. N. W. ¼, N. E. ¼, S. 10, T. 63-13. Mica hscist and granite 4 to 1.

HALT 398. N. E. ¼, S. E. ¼, S. 3, T. 63-13. Mica schist and granite as 5 to 2. The bedding is quite distinct, dipping N. 75°. The beds show increased tendency to separate, and we get some even laminæ half an inch to an inch in diameter.

HALT 399. S. W. ¼, S. W. ¼, S. 35, T. 64-13. Granite in about equal proportions with a black rock material apparently composed chiefly of lamellar hornblende or augite, with some scales of biotite.

Rock 171. Dioryte schist as above.

HALT 400. S. E. ¼, S. W. ¼, S. 34, T. 64-13. Coarse muscovite-gneiss. It contains a place folded around, as below:

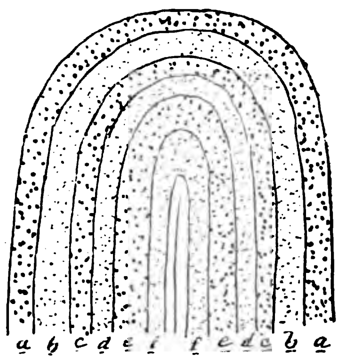

Fig. 21. Fold in the bedded rocks at Halt 400, Burntside L.
a, c, e, Coarse cherty.
b, d, f Fine cherty.

Rock 172. Large crystals of orthoclase.

Rock 173. Very coarse and muscovite-gneiss.

HALT 107. N. W. ¼, S. E. ¼, S. 23, T. 63-13. The rock here is a very compact dioritic schist. with very obscure bedding.

Rock 76. Compact dioritic schist.

The portage to Long lake leaves Burntside at this place.

HALT 108. S. E. ¼, S. E. ¼, S. 23, T. 63-13. On portage. Graywacke schist, very compact and hard, with many flinty veins. Strike N. 82° W. Dip. S. 45°. Portage from Burntside lake to creek into Long lake is about ¼ mile and good except at end, which is wet.

HALT 109. S. W. ¼, S. W. ¼, S. 24, T. 63-13. Entrance to Burntside river. Bosses of rock fifty feet high. Hydromica schist, compact, irregularly laminated, with many knots of feldspathic and siliceous matters. Contains also, moderate sized masses of flint and cherty material. Strike N. 50° E. Dip S. 82°.

Rock 77. Hydromica schist.

HALT 110. S. W. ¼, S. E. ¼, S. 24, T. 63-13. High outlier, 50 feet high. Graywacke, dark gray, with small feldspar nuclei and a dark and augitic mineral.

Rock 78. Graywacke from Halt 110, Burntside river.

§ 7. LONG LAKE.

Long lake lies wholly in the southern half of T. 63-12. Its main axis is N. 66° E., which is a greater inclination to the meridian than in the case of Burntside lake, and greater than is the case with the smaller lakes in the northern half of this township. The lake is about four miles long and three quarters of a mile broad, if we disregard the large bay upon the northwestern border. It is freer from islands than Burntside, but the rocky outcrops along the shore are nearly continuous. Ranges of rocky hills lie upon the north, but with trends somewhat less divergent from the meridian than the axi of the lake, and, in consequence, they approach the lake in their westward continuation. The direction of one of these ranges crosses the lake along the region connecting with the bay just mentioned, and its course is marked by a number of islands. The lake, on the whole, is excavated in the vertical edges of a mass of schists mostly sericitic, but in places chloritic, and occasionally replaced by graywake.

HALT 111. N. E. ¼, N. E. ¼, S. 30, T. 63-12. S. E. corner of

Long lake. Hydromica schist, dark greenish, compact, with an argillaceous aspect; weathering pale, yellowish greenish. Strike N. 60° E. contains a dike-like mass of a similar material, but weathering light, and with a very fibrous structure, striking N. 33° E. The fibres are so conspicuous as to present the appearance of a mass of *lignilytes*. This dike is 2½ feet wide.

Rock 79. Hydromica schist.

Rock 80. Fibrous hydromica schist in a dike.

HALT 112. N. W. ¼, N. W. ¼, S. 29, T. 63-12. Sericitic schist, but very similar to Halt 111. Strike N. 70° E. Many quartz veins. Dip S. 70°.

HALT 113. N. E. ¼, N. W. ¼, S. 29, T. 63-12. On a little island. Sericitic schist — same as on Vermillion lake. Strike N. 70° E.— and this is the trend of the island. Dip S. 75°. Some narrow beds of whitish, fibrous hydromica material, as at Halt 111 — but here conformable with the bedding.

Rock 81. Sericitic schist, pale greenish.

HALT 114. S. W. ¼, N. W. ¼, S. 29, T. 63-12. Point of main land. Chloritic sericitic schist, in places weathering to a pudding-stone aspect.

HALT 115. Island east of Halt 114. Chloritic sericitic schist, very compact. Dip S. 75°.

HALT 116. S. E. ¼, N. W. ¼, S. 29, T. 63-12. Island north of point. Fine, compact dioryte, but with the weathered aspect of a sericitic schist. The bedding is very obscure, and runs with the island. This is 125 feet wide, and the rock is of the same character from side to side.

Rock 82. Fine dioryte (?) from Halt 116.

HALT 117. N. W. ¼, S. W. ¼, S. 29, T. 63-14. Island close to point. Rock feebly schistose, in large part having a dioritic look, but in places somewhat like chloritic graywacke. The whole is only moderately hard.

Rock 83. Dioritic schist.

HALT 118. N. W. ¼, S. W. ¼, S. 29, T. 63-12. Graywacke schist, but very solid.

HALT 119. N. W. ¼, S. W. ¼, S. 29, T. 63-12. Graywacke schist in high bluff and intersected by veins of quartz.

HALT 120. Centre S. E. ¼, S. 30, T. 63-12. Sericitic schist in high cliff.

HALT 121. S. E. ¼, S. E. ¼, S. 30, T. 63-12. Graywacke schist.

HALT 122. N. W. ¼, S. W. ¼, S. 29, T. 63-12. Little island opposite Halt 121. North side a compact sericitic schist holding fragments of quartz porphyry,—and also fragments of porphyry—the whole of this having a fine brecciated aspect, as shown in the following diagram:

Fig. 22. Quasi-brecciated formation at Halt 122, Long Lake. F, felsite. Porphyry similar to F. Q, quartz. Sc. sericitic schist.

The laminæ are wrapped around the fragments of felsitic material exactly as if sedimentary.

The sericitic schist presents very diversified aspects; in places weathering greenish, in others whitish. Mostly it is free from hornblende, but in places crystals, of fibrous, dark-greenish hornblende lie imbedded in it—the longer dimensions mostly transverse to the lamination.

On the southeast side of the island, the formation changes to argillyte distinctly laminated and characteristic. The passage, however, is gradual. Dip S. 82°.

Rock 84. Sericitic schist porphyritic with hornblende.

Rock 85. Argillyte.

Rock 86. Sericitic schist.

HALT 123. Small island south side of bay. Chloritic argillyte. Dip S. 82°. Contains in joints a white mineral with transverse fibrous structure.

Rock and mineral 87. Chloritic argillyte.

HALT 124. S. W. ¼, S. E. ¼. Sec. 29, T. 63-12. Island. Pure, smoothly laminated sericitic schist, light colored, buffish.

Rock 88. Light, smooth sericitic schist, leather colored.

HALT 125. N. W. ¼, N. E. ¼, S. 32, T. 63-12. Island. Graywacke schist.

HALT 126. S. E. ¼, S. E. ¼, S. 29, T. 63-12. Main land. Finely mottled sericitic schist, crumbling into small scales under atmospheric action, forming a ridge 30 feet high which ranges with the schistose structure N. 39° E.

Rock 89. Sericitic schist finely mottled.

HALT 127. S. E ¼, S. E. ¼, S. 29, T. 63-12. Argillyte standing vertical, and graduating southward into the sericitic schist last seen. Schistosity strikes N. 20° E.

Rock 90. Argillyte.

In passing the angle of the land, we see a fine outcrop of argillitic sericitic schist. Further along, on the shore facing N. W., the same occurs.

HALT 128. N. E. ¼, S. E. ¼, S. 29, T. 63-12. South end of island. Sericitic schist, standing vertical and striking nearly north.

HALT 129. N. E. ¼, S. E. ¼, S. 29, T. 63-12. Main land. At the point, the argillyte stands like sheets on edge, 20 feet high.

HALT 130. S. W. ¼, S. W. ¼, S. 28, T. 63-12. Island, south end. Graywacke. The north end of the island is of sericitic schist.

HALT 131. Near centre of S. 28, T. 63-12. Sericitic schist, compact, irregularly laminated, chloritic.

HALT 132. Near centre S. 28, T. 63-12. Graywacke, so-called.

HALT 133. S. W. ¼, N. E. ¼, S. 28, T. 63-12. Sericitic graywacke, very fine.

HALT 134. S. W. ¼, N. E. ¼, S. 28, T. 63-12. Chloritic graywacke schist, bluish-green.

HALT 135. Centre of N. E. ¼, S. 28, T. 63-12. About same as last. Has quartz veins and pale green feldspar of pyrites.

Rock 91. Chloritic Graywacke.

HALT 136. S. W. ¼, S. W. ¼, S. 23, T. 63-12. Argillyte, fine grained, evenly laminated but compact.

Rock 92. Argillyte.

HALT 331. N. E. ¼, S. E. ¼, S. 22, T. 63-12. Yellow sericitic slates.

HALT 332. Near centre of section 22, T. 63-12. Chloritic sericitic schist—compact and rugged.

HALT 333. Near centre S. W. ¼, S. 22, T. 63-12. Sericitic schist, greenish, warped, rough weathering, chloritic. Strike N. 61° E. This is exactly the same as we saw at Halt 329. The harsh-weathering surface shows countless veins of quartz, felsyte and epidote, having a prevailing direction with the strike, but not at all conformable.

HALT 334. N. E. ¼, S. W. ¼, S. 22, T. 63-12. Chloritic schist, bluish, thin laminted.

Rock 152. Chloritic schist, somewhat sericitic.

Back of this, rock of Halt 333 recurs, making a thickness here of 300 feet.

We find great zones of dike-like aspect, in this formation; but they run, in some places, in exact conformity to the bedding, of varying width annd irregular walls. In one place I see one of these masses terminate in quartz and strike off diagonally across the bedding. These zones have, in places, a graywacke-like aspect and a schistose structure, and, when closely examined, show glistening, minute, white scales which I do not take for mica, but more probably damourite. But the mass of the dike has about the hardness of feldspar, and it appears like a mass of micaceous folia in a nascent — not well defined — state. I find here also, veins apparently of dolomite.

Another class of dike-like zones is silicous. They sustain about the same relation to the bedding as the dikes just mentioned. They range from rugged-weathering quartz to petrosilex.

Rock 153. Petrosilex as above.

This formation in all respects resembles that seen at Halt 321 — but is not identical — having a predominantly greenish color.

HALT 335. N. W. ¼, S. W. ¼, S. 22, T. 63-12. A hill at least 200 feet high separated by a thicket and a swamp from Halt 334. Did not visit it because it trends toward the lake and I expected to see it further west.

HALT 336. S. E. ¼, S. W. ¼, S. 2, T. 63-12. Little island. Sericitic schist, shaly and crumbling—not entirely smooth, but with small specks, as before seen.

HALT 337. S. W. ¼, S. W. ¼, S. 21, T. 63-12. Gnarled chlorite schist.

HALT 338. N. W. ¼, S. W. ¼, S. 21, T. 63-12. Gnarled chlorite schist.

HALT 339. S. E, ¼, S. E. ¼, S. 20, T. 63-12 Chlorite schist with many lenticular calcitic layers. Color green. Strike N. 81° E.

HALT 340. S. E. ¼. S. E. ¼, S. 20, T. 63-12. Island. Chloritic graywacke schist.

HALT 341. S. E. ¼, S. E. ¼, S. 29, T. 63-12. Inlet. Chloritic graywacke schist.

HALT 342. S. E. ¼, S. E. ¼, S. 20, T. 63-12. Compact chloritic graywacke schist.

HALT 343. N. E. ¼, S. W. ¼, S. 20, T. 63-12. Graywackenitic chlorite schist. The rock is of a greenish color, not conspicuously schistose, consisting of dark greenish chloritic material, in which appear many undefined crystals of a greenish feldspar apparently in a nascent state.

Rock 154. Wackenitic chlorite schist.

The rock is intersected by veins of granulyte with a little hydromica, and dikes of augite.

Rock 155. From an augite dike.

This resembles that seen on the west side of White Iron lake, but is harder.

These rocks rise in a conspicuous knob fifty feet above the lake, and trend northeast toward a hill seventy-five feet high. The strike of the range is N. 73° E., and I am quite certain the high hill of Halt 335 is here on the lake shore as was to be anticipated.

HALT 344. Centre of S. 20, T. 63-12. Blue, hard, much jointed chloritic rock.

HALT 345. ¼ mile W. of centre S. 20, T. 63-12. Chloritic graywacke schist.

HALT 346. N. E. ¼, S. W. ¼, S. 19, T. 63-12. Graywackenitic chlorite schist, irregular, compact and hard.

HALT 347. S. W. ¼, S. W. ¼, S. 19, T. 63-12. Chloritic argillyte. Dip S. 78°.

HALT 348. S. W. ¼, S. W. ¼, S. 19, T. 63-12. Argillitic chlorite schist.

HALT 349. S. W. ¼, S. E. ¼, S. 19, T. 63-12. Chloritic graywacke schist.

HALT 350. S. W. ¼, S. E. ¼, S. 19, T. 63-12. Argillitic chlorite schist.

The portage eastward out of Long lake is at the eastern ex

tremity. It is uncommonly good as far as the border of the marsh — dry, direct and smooth. It is almost a sort of turnpike. In the marsh the trail divides, one branch going directly to the creek and the other striking the creek further along. This part of the trail is exceedingly wet. The dry part is three-quarters of a mile long; the wet part one-third of a mile. The last third of a mile of the creek will take a canoe.

§ 8. FALL LAKE.

Fall lake lies chiefly in the northern half of T. 63-11. Its main axis trends N. 64° E., and is very nearly in continuation of that of Long lake. Its extreme length is about six miles, and mean breadth about two-thirds of a mile. It swells to a mile towards each extremity, while in the middle region, there are two places where the width is contracted to about one-sixth of a mile.

This is a very beautiful lake, but for scenic effects scarcely equal to Burntside. From the rounded point near the inlet of Fall river (Halt 290) the view down the lake northeastward embraces three or four miles, and the alternating vistas of land and water in the distance, produce a very pleasing effect. The falls near this point begin to acquire some celebrity, and when the means of access become easy, they and the fine lake will constitute a decided attraction for tourists. The stream in which the falls are situated comes in from Garden lake and carries the water which accumulates from Garden, Farm and White Iron lakes, as well as that from Birch and Stuntz lakes. The Kawishiwi river also empties into Farm lake, and this receives the drainage from an extensive region stretching to lakes Wilder and Isabella, in range 8. Fall river, therefore, is a stream of importance. The falls are known to the Indians as Ka-wa-sa-chong falls. They have also been called Cara Belle falls.

The falls as a scenic spectacle are very grand. The total descent is about thirty-five feet, and the volume of water, even in July, is surprisingly large. The fall is not one perpendicular plunge, but over the ragged wall of a precipice, which, on the east side, carries the water forward about fifteen feet, and on the west side, forty-five feet. The stream is divided about equally by a projecting rock-mass, and the portion on the west is again divided about ten feet down.

The entire volume of water is broken into a fury of foam and presents a spectacle of impressive grandeur. The roar of the

falls can be heard at the distance of two or three miles. As a natural phenomenon, these falls are all that the mind can duly appreciate. They are grander than Minnehaha, and the volume of water is eight times as great.

The water of the lake is clear and palatable. Like that of the other small lakes of the region, it rapidly acquires the mean seasonal temperature of the air—being rather warm during summer, but promptly cooling with the advent of autumnal weather. This lake, also, is well stocked with fish—especially pickerel, pike and bass.

The shores are generally less elevated than those of Burntside lake, and occasional short intervals of low and even marshy border occur. Generally, however, the shore is rock-bound and the facilities for geological study are ample. The rocks are very generally sericitic schist; but this in places, becomes chloritic or argillitic, or a strongly marked rudely-bedded, or even unbedded, chloritic rock, as at the falls. The bedding is everywhere approximately vertical. The general geology closely resembles that of Long lake, as would be inferred from its similar relations to the strike of the schists, and the coincidence in the lines of axis of the lakes.

Though the growing season must be short, the development of vegetation is luxuriant and rapid. I noticed several white pine trees of magnificent proportions—some attaining even a diameter of three feet. Considerable Norway pine occurs also, but the forest, where not burned off, consists of a mixed growth, including the aspen, the yellow and white birch, white cedar, spruce and fir. The luxuriance of some of the shrubs is rather astonishing. The mountain maple (*Acer spicatum*) grows everywhere most rankly, and rapidly chokes all neglected trails. I measured in one instance, on July 24th, a shoot of this season's growth, 4½ feet long. At the same time and place a red-berried elder shoot (*Sambucus pubens*), of this season's growth, measured 6 feet and 7 inches to the base of the terminal petiole, and 23 inches more to the tip of the leaf. Probably, under suitable cultivation, many crops will attain, in the vicinity of Fall lake, a very satisfactory development.

HALT 137. N. E. ¼, N. E. ¼, S. 34, T. 63-12. On town line, near western extremity of Fall lake, south shore. By the water's edge, an outcrop of brownish-buff sericitic schist, exactly the same as at Halt 124. In some of it is a tinge of red. This rock continues along the shore eastward.

HALT 138. S. W. ¼, S. W. ¼, S. 18, T. 63-11. Little island. Sericitic schist, bluish, crumpled and somewhat knotted — a little argillitic.

Main land around this southern bay presents no outcrop. Surface generally 20 to 30 feet high, covered with aspen, birch and spruce.

HALT 139. Near centre of S. 19. Main land. Sericitic schist, brownish, moderately compact, much like that at Halt 138.

HALT 140. Near centre of S. 19, T. 63-11. Point of land. Sericitic schist, like Halts 138 and 139. Does not split up in weathering, but presents a knotted and very irregular black surface.

As it has been suggested that a dike of diabase occurs at this place, with schist each side, I revisited the locality for the purpose of more particular study. The schists which I at first described as sericitic, are chloritic-sericitic, and weather in a ragged fashion, much like those at the falls. The dike, so called, strikes nearly with the schists — perhaps precisely so — but seems to dip southward at an angle of about 70°. The matter of the dike is diabasic in appearance — but yet is somewhat chloritic, and presents a resemblance to the schist. It is not certainly bedded, but there are lines of lamination, which, however, may be fluidal in character. Simple macroscopic observation will not probably suffice to decide whether sedimentary or not.

Rock 292. From the schist above described.

Rock 293. From the so-called dike at Halt 140.

HALT 141. S. W. ¼, N. E. ¼, S. 19, T. 63-11. Sericitic schist, but still more blue and more compact — verging toward graywacke schist. Somewhat chloritic.

HALT 142. N. W. ¼, N. W. ¼, S. 20, T. 63-11. Sericitic schist, compact, crumpled, bluish and olive — a little back, more massive, approaching graywacke schist.

HALT 143. S. W. cor. S. 17, T. 63-11. Main land. Sericitic schist, rather slaty, greenish-brown, like Halt 139.

HALT 134. S. W. ¼, S. W. ¼, S. 17, T. 63-11. Sericitic schist, compact, bluish and chloritic, much like Halt 142. Contains veins of felsyte.

HALT 297. S. W. ¼, S. E. ¼, S. 17, T. 63-11. A very compact and felsyte-like rock, firmer and finer than has heretofore been called graywacke.

Rock 146. Felsitic schist.

HALT 298. S. W. ¼, S. E. ¼, S. 17, T. 63-11. Chloritic graywacke schist.

HALT 299. N. W. ¼, S. W. ¼, S. 16, T. 63-11. Yellowish sericitic slates, much like Halt 292. The rock is thin-laminar, but the laminæ are somewhat wavy, from the interlamination of compact, rather hard, thin lenticules of siliceous matter. A few steps southward the rock is more evenly bedded and more greenish. Great slabs separate, which are five feet long, while not more than two feet wide, and three inches thick, as a maximum.

Between the wavy and the plain laminated beds is a little unconformity, like this:

Fig. 23. Surface unconformity at Halt 299. Fall I.
Vertical Wall.

This, however, is a surface phenomenon. Strike N. 40° E.; further west, N. 48° E. Dip of plain slates, S. 75°. The plain slates appear to assume a less steep attitude as they pass out of sight.

These slates are traceable along the beach, trending N. 21° E., for a distance of 402 feet. On the south they disappear under the earth. On the north they graduate into an irregular, unevenly bedded, chunky, sericitic schist, of a beeswax color. They might properly be styled *cericitic* schists.

HALT 300. S. W. ¼, N. W. ¼, S. 16, T. 63-11. Sericitic slates very similar to last. They seem to strike across the point and outcrop on both sides.

HALT 301. S. E. ¼, N. W. ¼, S. 16, T. 63-11. Sericiticslates, like last two Halts.

HALT 302. S. W. ¼, N. E. ¼, S. 16, T. 63-11. Sericitic slates, considerably rougher, with segregations of peroxide of iron. Strike N. 58° E. Dip S. 75°.

HALT 303. N. E. ¼, N. E. ¼, S. 16, T. 63-11. Sericitic schist, a little argillitic. Does not split in weathering. Strike N. 53° E. Dip S. 78°.

Rock 141. Sericitic schist, a little argillitic.

HALT 304. S. W. ¼, S. W. ¼, S. 10, T. 63-11. Sericitic schist exactly like last. Strike N. 48° E. Dip S. 86°.

HALT 307. S. W. ¼, S. E. ¼, S. 10, T. 63-11. Small outcrop of chlorite sericitic schist, massive and very unevenly bedded, having a bluish color. The stream marked on the plat as entering near here is not canoeable. I sought in the vicinity for a trail to the little lake in secs. 14 and 15, as I was informed that "black slate" occurs on the south side. But no trail could be found.

HALT 308. S. E. ¼, N. E. ¼, S. 10, T. 63-11. Mostly argilitic sericitic schist. At some points along the exposure, the rock is a graywacke schist, but it immediately passes into a smooth argillyte, and then eastward to an argillyte with sericitic surfaces and numerous grains disseminated, which give a pustulose surface, but are not distinct enough for determination in the field.

Rock 144. Sericitic argillyte with pustulose surface.

At the east extremity of this exposure are warped sericitic schisst, standing on edge and striking east and west.

HALT 309. S. W. ¼, N. E. ¼, S. 10, T. 64-11. Sericitic schist, warped and irregular and rather compact.

HALT 310. N. W. ¼, N. W. ¼, S. 11, T. 63-11. Exceedingly fine-textured sericitic argillyte. Strike N. 60° E.

Rock 145. Sericitic argillyte.

It is rather hard, apparently from the presence of finely disseminated feldspar.

HALT 311. N. W. ¼, N. W. ¼, S. 11, T. 63-11. Islet. Compact, irregular, bluish sericitic schist.

HALT 312. N. W. ¼, N. W. ¼, S. 11, T. 63-11. Sericitic schist with disseminated and undefined spots of bluish color and considerable iron, apparently limonitic.

Rock 146. Sericitic schist as above.

HALT 313. S. W. ¼, S. E. ¼, S. 2, T. 63-11. Sericitic schist, somewhat waxy and quite slaty.

Rock 147. Sericitic schist as above.

HALT 314. N. E. ¼, S. E. ¼, S 2, T. 63-11. Sericitic schist, a little more waxy than the last.

HALT 315. S. W. ¼, S. W. ¼, S. 36, T. 63-11. A high and

abundant outcrop of sericitic rocks. A good amount of variety. We have fine sericitic schist and bluish chloritic sericitic schist, and sericitic conglomerate, in which a fine sericitic schist weathering olive and fibrous, is filled with angular fragments of a material entirely similar, but more vesicular on the weathered surface — being crossed by innumerable interlacings of felsitic material. Some of these fragments are decidedly felsitic and some are graywacke-like in aspect.

Fig. 24. Pseudo-conglomerate, Halt 315, Fall Lake
Horizontal surface.

Careful study of this rock shows the fibres of the matrix adapting their direction to the form of the included masses, showing that these were deposited while the sediment was falling down.

At the same time, this is not completely a conglomerate, for we have: 1st, a common matrix in which these forms appear; 2d, these forms are so nearly of the mineral character of the matrix that they seem to be portions of the same rock; 3d, some of these forms blend insensibly with the matrix and look somewhat like segregations.

Rock 148. Sericitic pseudo-conglomerate, Halt 315.

It was impossible to get a standard specimen of a very characteristic one.

There is considerable quartz in the formation, partly disseminated and partly segregated.

Strike N. 55° E. Dip 90°.

HALT 316. S. E. ¼, S. W. ¼, S. 35, T. 64-11. Sericitic schists scarcely outcrop, but are abundant in somewhat slaty fragments.

HALT 317. S. E. ¼, S. W. ¼, S. 35, T. 64-11. Sericitic schist with chloritic spots. Strike N. 55° E. Dip 85° N.

Rock 149. Sericitic schist with chloritic spots.

HALT 318. S. E. ¼, S. W. ¼, S. 35, T. 64-11. Sericitic schist, same as last.

HALT 319. N. E. ¼, S. E. ¼, S. 3, T. 63-11. Sericitic schist, quite slaty. Dip N. 85°.

HALT 320. S. E. ¼, S. W. ¼, S. 3, T. 63-11. Sericitic schist with thin wavy laminæ and numerous disseminated undefined spots, as if some mineral were in process of disappearance. Strike N. 70° E. Dip N. 85°.

A few rods north it becomes regular, and very much seamed by quartz. Then, still further, it changes to waxy, rough sericitic schist.

HALT 321. S. E. ¼, S. W. ¼, S. 3, T. 63-11. Chloritic felsitic schist. Much and irregularly laminated, and weathering to white, bluish-green, black and purple. I have seen the same on Vermilion lake. The fresh-broken surfaces are predominately greenish—the weathered ones dun-whitish. Strike N. 55° E. Dip 85°.

HALT 322. S. E. ¼, N. W. ¼, S. 10, T. 63-11. Big island. Sericitic schist. Uneven layers. Strike N. 45° E. Dip N. 85°.

HALT 305. N. W. ¼, S. E. ¼, S. 9, T. 63-11. Buffish sericitic schists, not exactly like those on south shore.

These are not so smooth, but show a granular tendency. They are pervaded by minute grains appearing feldspathic. On weathered surfaces they dissolve out, giving the surface a finely cellular aspect.

Rock 142. Sericitic schist with small greenish grains.

In some parts are irregular laminæ of quartz. This rock is is in progress of transition, northward, into some other rock. This is like the schist of Halt 291.

HALT 306. S. E. ¼, S. W. ¼, S. 9, T. 63-11. Sericitic schist exactly like the last.

Rock 143. Sericitic schist from Halt 291, which I revisited to see if it is like that of Halt 305.

HALT 291. S. E. ¼, N. E. ¼, S. 18, T. 63-11. Sericitic schist, thin bedded, in wavy layers, soft and yellowish. Standing vertical like 305. Strike N. 55° E. The rock is 143, which see.

HALT 292. N. E. ¼, S. W. ¼, S. 18, T. 63-11. Sericitic schist like last, but more even.

HALT 293. An eighth of a mile north from Halt 292. Compact chloritic sericitic mass, little schistose.

HALT 294. A few rods north of last. Compact, firm, but

not very fine-grained, sericitic schist—massive, little schistose. In an elevated rocky ridge extending parallel with shore. Close by, the strike is N. 54° E., and the rock a more distinctly bedded sericitic schist.

HALT 295. One-half mile north from Halt 292. Chloritic sericitic schist, very compact, imperfectly bedded, much intersected by veins of similar material which show lines of structure parallel with the wall.

A little further north is an outcrop in which the vein-material, shown in figure 24, is so much expanded as to form more than half the bulk of the rock, and the formation appears like a very coarse conglomerate.

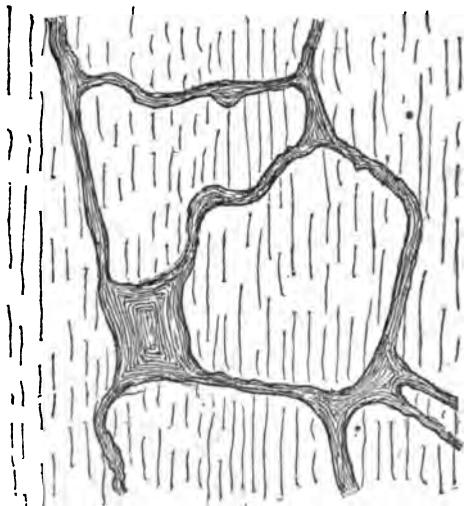

Fig. 25. Plan of veins at Halt 295, Fall Lake.

HALT 295 *bis*. N. W. ¼, S. W. ¼, S. 18, T. 63-11. Nearly half a mile back from the shore at Halt 292. Here a compact sericitic rock is interbedded with flint, but the layers are bent around so as to strike nearly north and south, or even west of north.

Fig. 26. Interbanding of flint and sericitic schist at Halt 295 bis, Fall Lake.

A few rods west, the formation is a massive graywacke rock, filled with ramifications of quartz, and containing irregular masses of rather soft, greenish rock.

HALT 296. A few rods west of Halt 295 *bis*. Outcrop of banded iron jaspilite—small, and not giving evidence of valuable ore—though evidently heavy ore may lie in close contiguity. I am told that this indication has been traced as far as the range line—about seven hundred and fifty paces west.

It is here in contact, on the north, with a sericitic schist containing a black mineral looking like columns of hornblende, or even tourmaline.

Rock 139. Sericitic schist and black crystals.

HALT 323. N. E. ¼, S. W. ¼, S. 18, T. 63-11. On the shore. Knotted, lumpy, chloritic sericitic schist.

HALT 324. Twenty rods west of Halt 323. Same as last. A range of rocks of this character stretches along the lake shore here, and strikes inland to Halts 293, 294, 295 and 296. The range here is about forty feet high.

HALT 325. Near township line. Well laminated sericitic schist, but with layers of a quartzose character, and others which appear to be dolomite. Color yellowish. Strike N. 60° E.

Rock 150. Sericitic schist, as above.

HALT 326. On township line. Sericitic schist, blue, with many layers hardened by deposition of (apparently) feldspar.

Rock 151. Sericitic schist, blue.

HALT 327. S. E. ¼, S. E. ¼, S. 13, T. 63-12. Gnarled sericitic chloritic schist, with layers of feldspar.

Rock 151 *bis*. Sericitic chloritic schist.

HALT 328. S. E. ¼, S. E. ¼, S. 13. T. 63-12. Sericitic chloritic schist, same as last.

HALT 329. S. E. ¼, S. E. ¼, S. 3, T. 63-12. The bluish sericitic schists graduate into greenish schists rough to the touch and giving a suspicion of fine mica. A few rods further south we have a very compact, fine-grained, greenish, felsitic schist, weathering dun-white and checked by joints and veins. Same as at Halt 320.

Included in this is a mass of graywacke-like rock weathering harsh, and including in itself some large lumps of iron jaspilite, in many cases bordered by films of epidote. The epidote intersects this mass also, in the form of veins. This graywacke-like mass is rudely conformable with the bedding of the formation, and occurs at two different horizons fifteen feet apart. The iron schist, however, is found only in the northern and older one. The range of iron schist seen at Halt 296, lies still further north.

Back of the last (that is, probably, northwest) come again bluish, rough sericitic schists with inter-laminations of feldspar, and some seams or veins or similar matter not conformable with the bedding, and with lamination conformable with the bedding of the formation. (Compare with Halts 1, 2 and 3.)

From the highest hills reached other hills are seen rising northward, in succession, to the horizon.

HALT 330. S. W. ¼, S. E. ¼, S. 13, T. 63-12. Graywackenitic chloritic schist.

The portage southward from Fall lake is about twenty rods east of the mouth of Fall river. It leads over a low ridge by a good path. Fragments of iron schist occur on the portage, and a rod from the trail, on the west, the rock outcrops.

§ 9 GARDEN LAKE.

Garden lake is a straggling body of water lying in the south half of T. 63-11—mostly in sections 20, 21 and 28. A large portion is rather of the nature of a broad and sluggish river, one branch of which flows out of Farm lake and the other out of White Iron lake, from which it is separated by rapids. The shores afford numerous outcrops of rocks, which are mostly schistose. Graywacke predominates along the southwestern border, as far as the eastern line of section 28, while south of this, sericitic and chloritic schists occur. The lake does not at-

tain the region of the syenite. A long southwestern arm stretching into section 30, reaches the neighborhood of a range of hæmatite which has afforded some specimens of marketable quality, and is believed by explorers to possess much value. At the southern extremity, near White Iron lake, are other indications of iron, which have prompted to some mining operations, and have given origin to the name Silver City.

HALT 145. S. W. ¼, N. E. ¼, S. 20, T. 63-11. Near head of rapids of Fall river. Compact, obscurely bedded graywacke, too hard to scratch, with seams having sericitic surfaces.

Rock 93. Graywacke.

Adjoining is a belt of banded iron schist — the continuation, probably, of that seen on the portage. The same graywacke continues down the rapids a quarter of a mile.

HALT 146. One-eighth mile down the rapids. The graywacke is highly ferruginous and more sericitic. It continues to the eastward bend in the river.

As the suggestion was made that what I have here designated graywacke is really a dike rock, I revisited the locality for more careful examination. The chloritic sericitic schists, as at Halt 140, are almost, if not quite, in contact with the alleged dike. The jaspilitic iron schist, also, can be traced to almost actual contact with it. Whether the dike rock, so called, presents truly the characters of a qualified graywacke or of a proper diabase, which it externally so much resembles, can hardly be ascertained without microscopic study.

HALT 147. N. W. ¼, S. E. ¼, S. 20, T. 63-11. South end of island. Knotted, scarcely bedded, sericitic schist, very hard, having a dike-like bed of fibrous, sericitic felsitic material, striking N. 31°E.— same as at Halt 111. Glacial striæ S. 21° W.

HALT 148. N. E. ¼, S. W. ¼, S. 20, T. 63-13. Chloritic argillitic sericitic schist, very compact, unevenly bedded, knotted and wavy.

HALT 149. S. E. ¼, S. W. ¼, S. 20, T. 63-11. Main land. Boss of solid graywacke, scarcely showing any bedded structure. It contains a chloritic constituent. On the top are some indications of structure striking N. 31° W.— but this direction is to be suspected, as the needle appears to be disturbed. A good deal of ferruginous matter appears in streaks.

Rock 94. Graywacke, compact and hard.

HALT 150. S. W. cor. S. W. ¼, S. 20, T. 63-11. Graywacke with the same diabasic aspect.

HALT 151. N. W. ¼, N. W. ¼, S. 29, T. 63-11. A massive outcrop of graywacke, still externally resembling diabase.

HALT 152. N. W. ¼, N. W. ¼, S. 29, T. 63-11. Graywacke as before.

HALT 153. N. W. ¼, N. W. ¼, S. 29, T. 63-11. Graywacke as before.

HALT 154. N. E. ¼, N. E. ¼, S. 30, T. 63-13. Enormous outcrop of similar graywacke, 40 feet high.

HALT 155. N. W. ¼, N. W.¼, S. 30, T. 63-11. Same diabase-looking graywacke to the extremity of this arm. Same rock continues on the east side of the arm. From this vicinity made an excursion into the centre of section 30.

HALT 286. Centre of S. 30, T. 63-11. On the iron range. Much flötz of banded iron jaspilite. Some specimens are fair ore; but I saw none here which was really minable. Capt. Julian Bausman, who accompanied me, says this range extends about ten degrees north of east for a distance of half a mile.

Here is a clearing of about one acre, in the midst of a dense forest of slender Norways and tamaracks; and a log cabin stands in the centre. This spot is on the slope of a hill on the border of a swamp.

HALT 287. 50 rods west of last. On a hill the iron jaspilite outcrops rather extensively. I see, however, no fine ore. The black bands in the jaspilite are too hard to scratch.

HALT 288. Twenty rods still further west. Here are fragments of good minable hæmatite. Query: Does the range lie in continuity with the Tower iron range? Or, with the range south of Mud lake?

Rock 136. Banded jaspilite (about thirty bands).

Rock 137. Best iron ore at Halt 288.

HALT 289. N. W. ¼, S. E. ¼, S. 20, T. 63-11. Island. Chloritic argillitic schist.

HALT 156. Centre of N. W. ¼, S. 29. Chloritic sericitic schist, very compact. Like Halt 148.

HALT 157. Near 156. Graywacke rocks.

HALT 157 *bis*. S. E. ¼, S. E. ¼, S. 20, T. 63-11. Chloritic sericitic schist, uneven-bedded, compact.

HALT 158. N. E. ¼, N. E. ¼, S. 29, T. 63-11. Graywacke, a little schistose.

HALT 159. S. W. ¼, S. W. ¼, S. 21, T. 63-11. At point of main land. Graywacke a little greenish.

HALT 160. N. E. ¼, N. W. ¼, S. 28, T. 63-11. Graywacke still, very fine and massive.

Rock 95. Graywacke, very massive.

HALT 161. S. E. ¼, N. W. ¼, S. 28, T. 63-11. Graywacke.

HALT 162. Centre N. E. ¼, S. 28, T. 63-11. Graywacke.

HALT 163. S. E. ¼, N. E. ¼ S. 28, T. 63-11. Chloritic sericitic schist, obviously slaty, but irregular. Strike N. 71° E.

Rock 96. Chloritic sericitic schist.

HALT 164. S. E. ¼, N. E. ¼, S. 28, T. 63-11. Chloritic sericitic schist, very distinctly laminated. Strike N. 71° E. Dip vertical.

Rock 97. Sericitic schist.

HALT 165. S. E. ¼, N. E. ¼, S. 28, T. 61-11. Chloritic schist, medium-bedded, greenish. Dip S., about 85°.

Rock 98. Chloritic schist.

HALT 166. S. E. ¼, N. E. ¼, S. 28, T. 63-11. Chloritic argillite, compact. Strike N. 71° E.

HALT 167. N. W. ¼, S. W. ¼, S. 27, T. 63-11. Exposure on north side, chloritic graywacke; on south side, sericitic argillite, distinctly laminated

HALT 168. N. W. ¼, S. W. ¼, S. 27, T. 63-11. Graywacke.

HALT 169. N. W. ¼, S. W. ¼, S. 27, T. 63-11. Chloritic graywacke, varying to compact chloritic schist. Contains in places a red mineral, like heulandite. Also veins of quartz with much iron.

Rock 99. Chloritic graywacke with red mineral.

HALT 170. N. W. ¼, S. W. ¼, S. 27, T. 63-11. Chloritic graywacke.

HALT 171. N. W. ¼, S. W. ¼, S. 27, T. 63-11. Chloritic graywacke.

HALT 172. S. E. ¼, S. E. ¼, S. 25, T. 63-11. West end of island. Sericitic argillite, very hard and imperfectly bedded. Dip N. 80°.

HALT 173. N. E. ¼, S. E. ¼, S. 27, T. 63-11. Fine hornblendic sericitic schist.

HALT 174. S. E. ¼, S. E. ¼, S. 29, T. 63-11. Silver City. A mining drift excavated about forty feet. The formation is essentially quartz standing in vertical beds, and mostly interbedded with hæmatite and limonite. At the entrance, the drift materials are firmly cemented with limonite apparently filtered out of the formation by percolating water. Next, the quartz beds are much shattered, and mixed with iron. Ten feet in, which

is across the bedding, the formation becomes sericitic schist, somewhat as shown in Fig. 27.

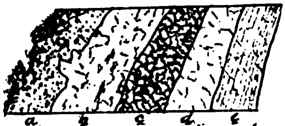

Fig. 27. Stratification at Silver City, Garden Lake.
a, Sand and pebbles, cemented with much limonite.
b, Ferruginous quartz.
c, Ferruginous quartz broken up
d, Quartz.
e, Sericitic quartz.
Vertical face.

Rock 100. Quartzyte from Halt 174.

On the opposite side of the point is another similar drift with similar showing.

HALT 175. N. E. ¼, N. E¼, S. 32, T. 63-11. Foot of rapids from White Iron lake.

HALT 176. Across the rapids from Halt 175. The schists present a towering, columnar aspect, and, on examination, are as follows:

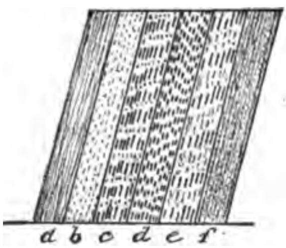

Fig. 28. Columnar schists. at Silver City, Garden L.
a, sericitic mica schist, fine.
b, mica schist.
c, mica-hornblende schist.
d, hornblende schist.
e, ferruginous hornblende schist
f, jaspery iron-schist.
Vertical cliff.

Here seems to be a transition from sericitic to mica schist, and thence to hornblende schist, and still further to jaspery iron schists. The iron comes in gradually, and by intercalation with the hornblende and silicious schists.

Strike of beds could not be ascertained. The needle, when near the cliffs, presented south end to them; at the distance of fifteen feet, it presented north end to the cliffs.

Rock 101. Sericitic mica schist.

Rock 102. Micaceous hornblende schist — little hornblende.

Rock 103. Hornblendic magnetic schist.

The above series of beds is situated south of the quartzite of Halt 174.

I am led to offer a remark on the mining explorations at Silver City — so-called. The result should have been foreseen. A small expenditure over the surface in uncovering the outcrop of the formation would have revealed the probable nature of the succession of beds, as well as the costly burrowing under the ground, since the drift goes directly across the beds. Another consideration renders the venture an ill-advised one. The tunnel (Fig. 28) penetrates the formation at a place where the beds run out on the shore in both directions, within a short distance, so that if any bed, as *a*, had been found rich in iron, there would not have been enough of it to repay expense of the tunnel.

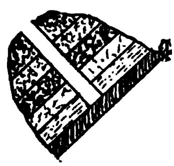

Fig. 29. Relations of Tunnel to stratification at Silver City, Garden Lake, Halt 174. Plan.

HALT 225. S. E. ¼, S. E. ¼, S. 20. T. 63-11. Island. Felsitic, hornblendic schist. Same as No. 6, Halt 224, White Iron lake.

Rock 127. Felsitic hornblendic schist.

Rock 128. Sericitic silicious schist.

It varies to felsitic mica schist and to sericitic silicious schist. Some intruded syenite appears. The schist weathers to a strikingly columnar aspect, forming miniature palisades.

HALT 226. S. E. ¼, S. E. ¼, S. 29, T. 63-11. Interstratifications of knotted, chloritic schist, sericitic silicious schist and silicious schist.

HALT 227. S. E. ¼, S. E. ¼, S. 28, T. 63-11. Very fine, almost aphanitic, mica schist, weathering to a columnar structure.

HALT 228. S. E. ¼, S. E. ¼, S. 28, T. 63-11. Mica schist, silicious and evenly bedded. Good flagstone.

Rock 129. Mica schist.

HALT 229. S. W. ¼, S. W. ¼, S. 27, T. 63-11. Silicious and micaceous iron schists.

HALT 230. A few rods S. of Halt 229. Graywackenitic mica schist. Similar to Halt 227.

HALT 271. Centre of S. W. ¼, S. 27, T. 63-11. Graywackenitic mica schist.

HALT 272. Centre of N. W. ¼, S. 27, T. 63-11. Fine hornblendic mica schist, with indications of iron in the formation.

HALT 273. N. W. ¼, S. W. ¼, S. 27, T. 63-11. Rock at point a mixture of norite, dioryte and hornblendic mica schist. Back a few rods, mostly mica schist with quartz.

HALT 274. S. W. ¼, N. W. ¼, S. 27, T. 63-11. Nodular chloritic schist with signs of iron.

HALT 275. S. W. ¼, N. W. ¼, S. 27, T. 63-11. Compact, bluish, nodular, somewhat chloritic, almost aphanitic paste quite diabasic in external appearance.

HALT 276. N. W. ¼, N. W. ¼, S. 27, T. 63-11. Chloritic, nodular, diabasic-looking rock.

HALT 278. N. E. N. W. ¼, S. 27, T. 63-11. The outcrop, judging from a specimen brought, is a compact chloritic schist.

HALT 277. N. W. ¼, N. W. ¼, S. 27, T. 63-11. Surfaces thinly drift-covered.

HALT 279. N. E. ¼, N. W. ¼, S. 27, T. 63-11. Chlorite schist.

HALT 280. N. E. ¼, N. E. ¼, S. 21, T. 63-11. Chlorite schist.

HALT 281. N. E. ¼, N. E. ¼, S. 21, T. 63-11. Chlorite schist.

HALT 282. N. E. ¼, N. W. ¼, S. 21, T. 63-11. Chlorite schist a little more argillic than the last.

HALT 283. S. E. ¼, S. W. ¼, S. 21, T. 63-11. Porphyry.

Rock 135. Porphyry. This, perhaps, is a variety of so-called porodite.

HALT 284. S. E. ¼, S. W. ¼, S. 21, T. 63-11. Chlorite schist, compact and massive.

HALT 285. N. W. ¼, S. W. ¼, S. 21, T. 63-11. Chlorite rock —a bold and massive exposure.

§ 10. WHITE IRON LAKE.

This considerable lake diverges less from the meridian than Burntside, Long and Fall lakes. Its mean axis bears N. 30° E. Its extreme length, following the slight curvature toward the east, is six and one-half miles, while its length in a straight line is five and two-thirds miles. It has a mean diamater of about three-fourths of a mile, but, like Fall lake, it is narrowed at two places near the middle. The greatest body of the lake is located in T. 62-11, but it extends across the corner of T. 61-11 and into the corner of T. 63-11. Its shores are clothed with the usual timber growths of the region, with a comparative scarcity of pines, and corresponding abundance of spruce, aspen and white birch. Fire has devastated extensive areas on the northeast shore. Rocky outcrops are sufficiently frequent for geological study of the region, but they are almost wanting along the southwestern border, and also along the northeastern. The rocks are almost exclusively syenite and syenitic gneiss, and these are present in many varieties. The shores of the bay lying in section 18 of township 62-11 were not visited, as they were assigned to another explorer.

HALT 177. N. W. ¼, N. E. ¼, S. 32, T. 63-11. Rock bluish-gray very fine, schistose with glistening particles which seem to be micacious. Hornblende (or augite) seams present. It may perhaps be regarded as micaceous graywacke—a graywacke in which mica occurs in an early stage of formation.

Rock 103. Nascent mica schist.

HALT very near last. The fundamental rock is the same as last (nascent mica schist) but here are veins of fine granite, which in places, is without mica, and in places contains a little hydromica or possibly hornblende. Over the surface lie strewn fragments of biotite syenite, which perhaps do not belong here.

Rock 104. Granulite vein.

Rock 105. Biotite syenite.

HALT 179. S. W. ¼, N. W. ¼, S. 32, T. 63-11. Syenite with some biotite. Rock same as 105. I notice fragments of hornblende schist included in it.

Rock 106. Syenite with fragments of hornblende schist.

HALT 180. N. E. ¼, N. E. ¼, S. 30, T. 63-11. Mass of syenite. A 5-inch vein of quartzyte runs through it. The formation covers the whole point and outcrops on both sides.

HALT 181. S. W. ¼, N. W. ¼, S. 31, T. 63-11. Syenite.

Some indications of included portions having a bedded structure.

HALT 182. S. W. ¼, N. E. ¼, S. 31, T. 63-11. Syenitic gneiss with distinct tendency to irregular, rather thin, beds. Hornblende more limited than last, but much free quartz disseminated through the reddish orthoclase.

Rock 107. Syenitic gneiss.

Schistosity N. 20° E. A vein of syenite, with red feldspar running N. 78° W., intersects the formation.

Rock 108. Syenite with vein as above.

HALT 183. S. N. ¼, N. E. ¼, S. 31, T. 63-11. Syenitic gneiss like that of Halt 182, but there is plenty of hornblende with pale red orthoclase.

I find loose pieces with much pale red orthoclase making quite an ornamental stone. Like the vein-stone of Halt 182.

Rock 109. Syenite with much red orthoclase.

HALT 184. Near centre of S. 31, T. 63-11. Syenitic gneiss like Halt 182.

HALT 185. N. E. ¼, S. W. ¼, S. 31, T. 63-11. Syenitic gneiss with red orthoclase, like Rock 109.

HALT 186. N. E. ¼, S. W. ¼, S. 6, T. 62-11. Island. Syenitic gneiss.

HALT 187. N. W. ¼, S. W. ¼, S. 6, T. 62-11. Another island. Muscovite schist, but profoundly intersected by veins of syenite, like that seen for a long distance back. Looks like a transition between the two. But the mica scales are not small.

Rock 110. Muscovite schist.

The same occurs at the south end of the island.

HALT 188. S. W. ¼, S. W. ¼, S. 6, T. 62-11. The north end of this exposure is fundamentally muscovite schist, with crystals of pink orthoclase disseminated through it. In places it approaches gneiss. It is thoroughly cut up with veins of syenite. A few rods south the whole mass is syenite.

Rock 111. Muscovite schist.

HALT 189. S. W. ¼, S. W. ¼, S. 1, T. 62-12. Syenite as before.

HALT 190. S. E. ¼, S. W. ¼, S. 1, T. 62-12. Syenite, but with the pinkish orthoclase are crystals of a glassy feldspar. This syenite forms the whole point.

Rock 112. Syenite with crystals of glassy feldspar.

HALT 191. N. W. ¼, N. W. ¼, S. 12, T. 62-12. Syenite, including fragments of muscovite schist.

HALT 192. N. W. ¼, N. W. ¼, S. 12, T. 62-12. Syenite with red feldspar and coarse grains of quartz.

HALT 193. S. W. ¼, S. W. ¼, S. 12, T. 62-12. The mass of the exposure is syenite or syenitic gneiss with pale orthoclase. It contains a bed or intrusion of syenite, with abundance of red orthoclase. It also incloses masses of schist composed of feldspar, which weathers red, and dark minerals which appear like dark muscovite and some hornblende (or augite), also grains of quartz.

Rock 113. Hornblendic? (augitic) mica schist.

Abundant masses of what I take for augite rock lie about—wholly massive.

Rock 114. Augite rock. (Too soft?)

HALT 194. S. W. ¼, S. W. ¼, S. 12, T. 62-12. Dike of augite 30 feet wide. On the north is syenite with red feldspar. On the south, syenite with a glassy feldspar and abundant hornblende. The latter is a rather fine-grained and handsome rock, but with a very dark tone. The northern syenite is also a handsome rock with pink tone.

Rock 115. Syenite with glassy feldspar.

Rock 116. Augite rock.

The augite is intersected by veins of red syenite, and contains detached masses of it. South of the dark syenite the red reappears.

HALT 195. S. W. ¼, S. W. ¼, S. 12, T. 62-12. Red syenite.

Considerable search was made for a portage out of White Iron lake toward the south and through the stream which comes in from the lake in section 33. There is no thoroughfare to Stuntz lake in this direction. Subsequently I was informed that it is possible to pass the rapids with a light canoe; and that is the course generally pursued.

HALT 196. S. E. ¼, S. W. ¼, S. 24, T. 62-12. Red syenite, as before. It presents a distinct schistosity, striking N. 53° E.

HALT 197. N. E. ¼, N. W. ¼, S. 25, T. 62-12. Red syenite with a vein of fine, compact syenite.

Rock 117. Red syenite with vein of syenite attached.

HALT 198. N. E. ¼, N. W. ¼, S. 25, T. 62-12. Enormous mass of syenite—the feldspar light colored and very coarse. Hornblende also coarse. Intersected by vein of compact syenite.

HALT 199. N. E. ¼, N. W. ¼, S. 25, T. 62-12. Boss of syenite rising 70 feet above the bay. Crystals of feldspar still larger—some being ¾ inch long.

HALT 200. S. E. ¼, S. W. ¼, S. 24, T. 62-12. Syenite, the same as at Halt 199.

HALT 201. S. W. ¼, S. E. ¼, S. 24, T. 62-12. Some porphyritic syenite. It contains a dike of hard, bluish-gray, fine diabase, striking N. 17° E., and forming a sharp junction with the syenite. The dike is eleven feet wide, and both walls of syenite are straight as a rule. It dips east at an angle of 80°.

HALT 202. N. W. ¼, S. W. ¼, S. 24, T. 62-12. Island. Syenite, coarse as before.

HALT 203. N. W. ¼, S. E. ¼, S. 24, T. 62-12. Syenite as before. Contains a vein composed wholly of large orthoclase crystals.

HALT 204. Near centre of section 24. Island. Could not land, but rock looks like gray syenite.

HALT 205. Centre of N. E. ¼, S. 24, T. 63-12. Syenite, but lighter colored.

HALT 206. N. E. corner, S. 24, T. 62-12. Syenite with light feldspar. On the east it becomes fine-grained and gneissic.

HALT 207. S. E. ¼, S. E. ¼, S. 14, T. 62-12. South end of island. Mass of Syenite still coarse, but the feldspar crystals not so conspicuous. The hornblende black and shining.

HALT 208. N. E. ¼, S. E. ¼, S. 13. East side of island. Syenite with pinkish orthoclase and brilliant black hornblende.

HALT 209. S. E. ¼, N. E. ¼, S. 13, T. 63-12. Syenite, coarse grained and fine.

HALT 210. N. E. ¼, S. E. ¼, S. 6, T. 63-12. Near point. Nothing here but sparse drift.

HALT 211. S. W. ¼, S. E. ¼, S. 12, T. 62-12. Syenite gneiss, medium texture, feldspar but slightly pinkish. Contains narrow veins of fine syenite. It embraces a large mass of muscovitic hornblende schist which is profoundly penetrated by veins and detached masses of syenite which are generally less hornblendic than the main gneiss.

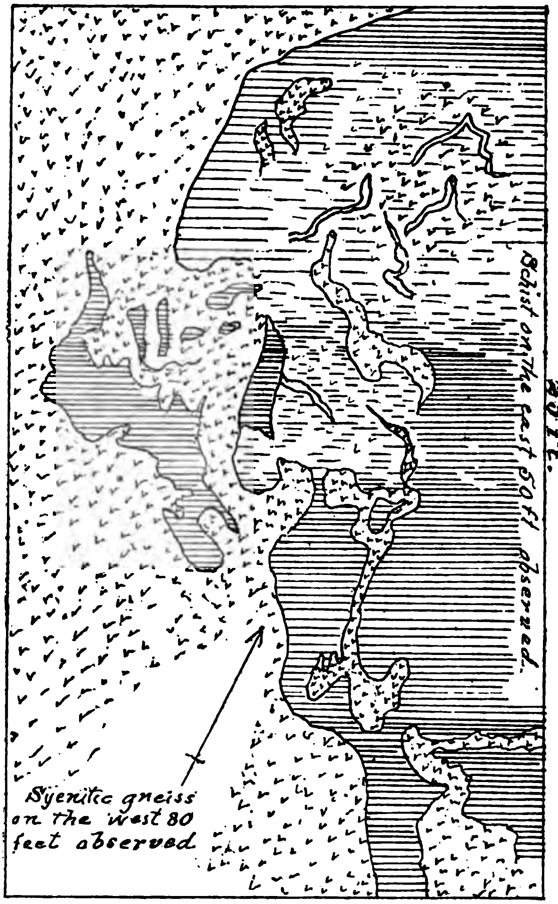

Fig. 30. Syenite inclosing masses of veined schist, Halt 211, White Iron Lake.

The syenitic intrusions continue as far as the schist can be traced.

The syenite on the opposite side embraces innumerable detached fragments of the schist. Portions of the schist are more exclusively muscovitic, others more hornblendic.

Rock 118. Syenite or syenitic gneiss from this locality.

Rock 119. Muscovitic hornblende schist showing junction with syenite.

Proceeding east 20 rods, schist continues, and in a bold expos-

ure, shows the syenite penetrating it extensively and in every direction.

HALT 212. N. W. ¼, S. E. ¼, S. 12, T. 62-12. Syenite.

HALT 213. N. W. ¼, S. E. ¼, S. 12, T. 62-12. Syenite, but the constituents are more blended — the feldspar being reddish, and a somewhat compact mass through which the quartz and hornblende are disseminated. The latter is not in the brilliant black fibrous fragments of the syenite passed over, but dull and somewhat clay-colored. The rock, also, is not homogeneous, but includes pebbles of compact felsitic granulite.

HALT 214. S. E. ¼, N. W. ¼, S. 12, T. 62-12. Syenitic gneiss with the usual bright hornblende and a reddish feldspar.

HALT 215. N. W. ¼, N. E. ¼, S. 7, T. 62-11. Syenite. This has reddish feldspar, and also many large, isolated, distinctly outlined, squarish fragments of quartz. This is like much syenite heretofore seen.

HALT 216. N. E. ¼, N. W. ¼, S. 7, T. 63-11. Syenite like last.

HALT 217. S. E. ¼, S. W. ¼, S. 6 on section line, T. 62-11. Syenite with reddish feldspar, and some disseminate quartz grains.

Rock 120. Syenite from Halt 217.

HALT 218. S. E. ¼, S. W. ¼, S. 6, T. 62-11. Syenite with much reddish feldspar. Embraces masses of syenite of dark color from abundance of hornblende, and of fine texture. Glacial striæ S. 29° W.

HALT 219. Near centre of section 6, T. 62-11. Syenite with red orthoclase and rectangular faces of glassy feldspar.

HALT 220. Near centre of S. 6, T. 62-11. Essentially a reddish syenite; but it incloses several varieties of syenite in lump-like forms. One is a fine-grained variety; another is composed mostly of a dark-greenish hornblende in isolated fragments imbedded in a matrix of pinkish feldspar. Some portions of the main rock are coarse, with large fragments of quartz and feldspar. In some portions the hornblende is bright black, in others dull and greenish.

HALT 221. Near centre S. 6 (east), T. 62-11. Outcrop of dark color, containing biotite, a pale greenish feldspar, some augite in black lamellar crystals, and scattered grains of quartz.

Rock 121. Biotitic quartzose diabase.

This rock extends along the shore about ninety feet in a direction nearly north and south. Toward its southern limits it receives

a little pinkish feldspar and a little quartz, and then more feldspar and more quartz, while the biotite is partly replaced by hornblende, and the rock is a biotitic syenite. Toward the southern limit also, this rock becomes invaded by roundish masses of syenite, some of which is exactly like that noticed at Halts 215 and 217.

Rock 122. Biotitic diabase with accessions of orthoclase and quartz.

Rock 123. Biotitic syenite connected with Rock 122 by transition.

On the north, the formation is limited by a very compact rock in which reddish orthoclase and bluish-gray earthy matters are blended but not thoroughly mixed.

Rocks 124 *and* 125. Rock last mentioned.

HALT 222. One quarter mile N. of centre of S. 5. T. 62-11. Rocky point but not certain outcrop.

HALT 223. N. E. ¼, N. E. ¼, S. 32, T. 62-11. Rock fine, clay-bluish, with glistening points which I think are small muscovite scales. Other constituents are a glassy and greenish feldspar, and a dark mass which I take to be augitic.

Rock 126. Micaceous graywacke schist — a nascent muscovite schist.

Parts of the rock are intersected by a net work of silicious veins exactly as seen in some boulders at Ann Arbor.

Immediately adjoining on the north, the formation is a muscovite schist. Then still further north, within sixteen rods, the formation is a laminated mixture of mica schist, silicious schist and magnetic schist. The needle reverses its direction within distances of six inches. All these schists stand vertically.

HALT 224. N. E. ¼, N. E. ¼, S. 32, T. 63-11. Here mica schist and syenite form a junction, with phenomena similar to those before described. Masses of syenite are included in the mica schist on the north, while at one point, the junction with the mass of syenite is abrupt for the space of five feet. The schist here is hardened with thin leaves of silicious matter banding it, and small lenticular bands of magnetite.

On the syenite side, however, within two feet, the syenite contains fragments of mica schist, hornblende schist, imbedded augite rock with coarse crystals (like that seen at Halt 194), lenticular masses of hornblende gneiss and a peculiar diorite, with the longer axes of the hornblende fragments all turned in one direction; also diorite fragments of finer texture. The diorite fragments are decidedly numerous for a distance.

This syenite passes through the intermediate of coarse quartzose syenite into a compact reddish quartzite which I traced fifteen feet, into the bank.

The needle, over the junction of the mica schist and syenite, is reversed, and does not resume its proper direction in the vicinity. The mica schist, however, stands vertical, and its strike is about forty-three degrees east of north.

We have then, at this intersecting point, the following succession, beginning on the south:

1.	Reddish quartzite (passing into)......................	15 feet
2.	Reddish syenite containing many detatched fragments, as described..	6 feet
3.	Mica schist, trending about N. 43° E. and forming a sharp junction, at certain points, with the next, and becoming hornblendic in the vicinity............	
4.	Reddish syenite again which, as before, incloses masses of mica schist and hornblende schist......	12 feet
5.	Hornblende schist with fibrous structure.................	6 feet
6.	Interlaminations of hornblende- and felsitic schist, growing more and more aphanitic....................	4 feet
7.	Ferruginous sericitic schist, strongly iron colored......	2 feet
8.	Transition between mica- and hornblende schists.....	4 feet
9.	Red syenite 190 feet, and passes under the ground.	

§ 11. FARM LAKE.

This lake consists of a body having a general oval outline about one mile in average width, and lying mostly on the south border of T. 63-11. With this is connected by a stream, rocky, rapid and not canoeable, a small lake on the boundary line between this and town 62-11. The shores present no important outcrops on the west and south, but several occur on the east; and a small island not on the plats, which I have named Geology island, presents an exhibition of remarkable interest. It lies in the belt of junction of the syenite and schists. This little spot I studied thoroughly, foot by foot, much of the time on my knees, and my notes contain a description as detailed as could be drawn up from field observations. The timber adjacent possesses no special value or interest.

HALT 231. N. W. ¼, N. E. ¼, S. 3, T. 63-11, on town line Porphyritic syenite. Feldspar crystals an inch long, some of them clear as sanidin.

Rock 130. Diabase from dike mentioned below.

Rock 131. Porphyritic syenite. (This rock is marked by mistake "129.")

The syenite is intersected by a dike of diabase seven feet wide, striking east and west, and having a dip N. of 60°. Glacial striæ S. 21° W.

HALT 232. S. W. ¼, S. E. ¼. S. 34, T. 63-11. Porphyritic syenite. Feldspar crystals so large that the weathered surface of the rock resembles a conglomerate. Intersected by beds of finer-grained syenite.

HALT 234. S. E. ¼, S. E. ¼, S. 34, T. 63-11. Coarse syenite—low outcrop.

HALT 235. S. E. ¼, S. E. ¼, S. 34, T. 63-11. Porphyritic syenite in two portions, separated by twenty feet of fine syenite.

HALT 233. S. W. ¼, N. E. ¼, S. 34, T. 63-11. Geology island. I first walked over most parts of this island, and found its geology very complicated. It does not even appear what is the fundamental formation. I find syenite, diabase dikes, mica schist, hornblende schist and silicious schist under various aspects and alternations. In the following description I will begin at the south end, and following the west shore, note what appears.

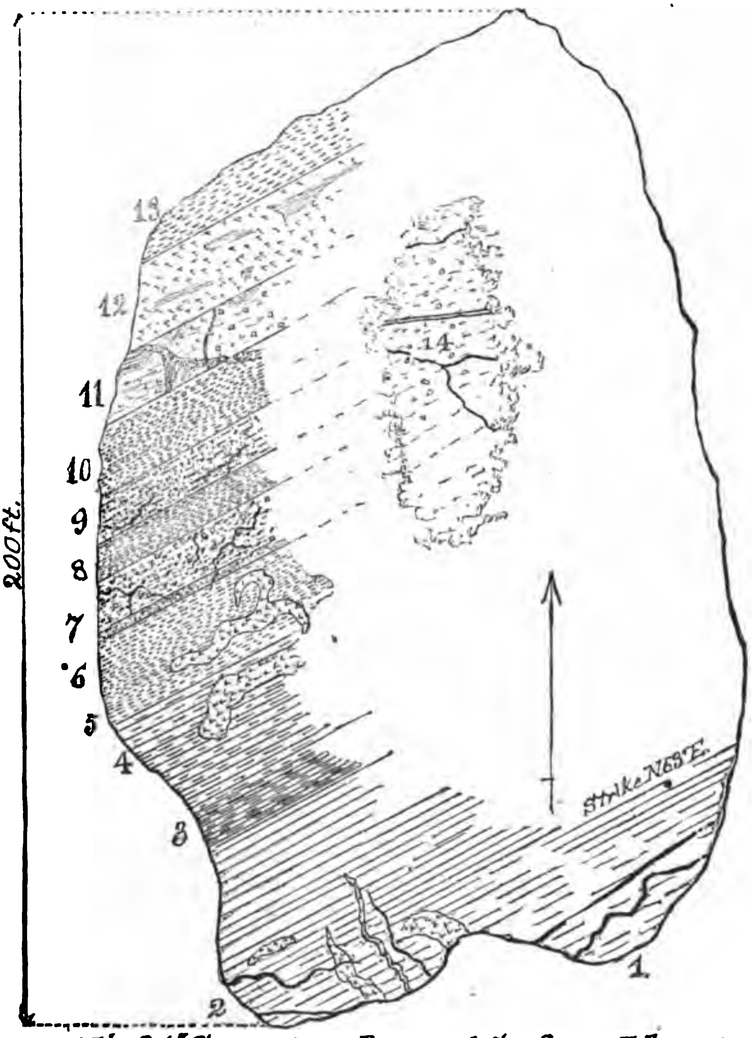

Fig. 31. General geology of Geology Island in Farm Lake, Hall 233.

The numbers show the points referred to in the following description:

1. At the southeastern extremity of the island. Mica schist, striking N. 61° E., and with a S. E. dip of about 75°. It is intersected by many veins of quartzose syenite.

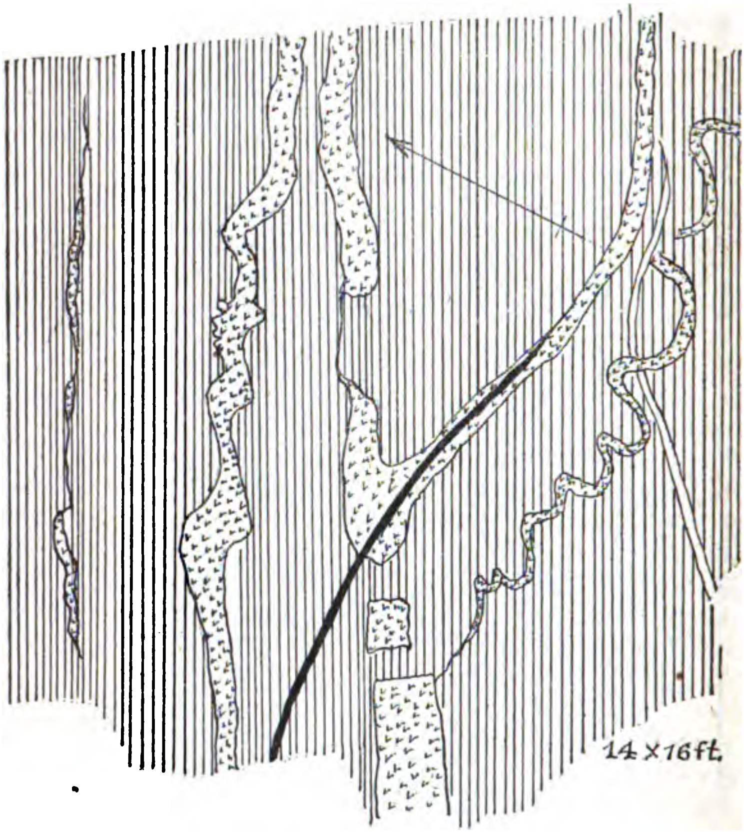

Fig 32. Veins of quartz and quartzose syenite in mica schist, Geology Island. Farm Lake.

2. The mica schist is traceable uninterruptedly to this, the most southern point of the island—at frequent intervals intersected by veins of compact syenite. At 2 *a* is a mass of syenite not in form of a vein.

3. Mica schist more compact, weathering into columnar forms. About six rods from 2.

4. Here a mass of syenite is included in the schist.

5. Very fine, compact, heavy-bedded biotitic syenite gneiss. This is reached by gradation from regular mica schist, both in the direction of the strike and across it. It is intersected by

many masses of reddish granulyte. In the granulyte are also included vein-like forms of quartz — or rather flint. Here also are veins of beautiful syenite, with large crystals of hornblende. An interesting case is shown in figure 33.

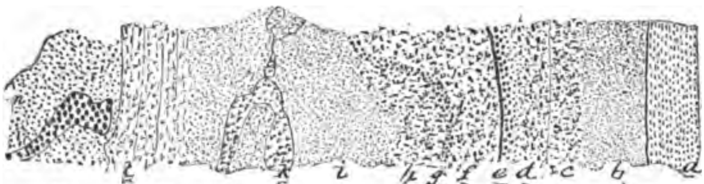

Fig. 33, Detailed geology of a point on Geology Island in Farm Lake, Halt 238.

a. Mica schist very fine and compact.

b. Fine, hard, almost vitreous diabasic matter, running with the bedding, but dike-like and not separated by any line from *c.*

c. First comb of a syenite vein in which the ample crystals of hornblende have their longer dimension transverse.

d. Second comb of syenite, in which the hornblende crystals have their longer dimension coincident with the walls of the vein.

e. A comb of granulyte not isolated on either side — very vitreous.

f. Third comb of syenite, in which the hornblende fragments are variously disposed.

g. Second comb of vitreous granulite.

h. Fourth comb of syenite, in which the hornblende is disposed as in *c.*

i. Nearly like *b.*

k. A vein of common syenite.

l. A portion which has become gneissic, but very fine and flinty.

m. A black substance resembling hornblende pulverized and compacted again.

Rock 132. The black substance last mentioned.

n. The portion indicated as red and smoky quartz at this point varies in character from foot to foot. It becomes, perhaps, predominantly, a flinty granulite, with lumps of smoky quartz. The whole mass passes to the water's edge as a regular dike five and one-half inches wide, with a strike N. 68° E. and a dip S. 61°.

7. For two feet beyond this dike the rock is a flinty, fine syenitic gneiss; and this is succeeded by a fine mica schist, in which small grains of quartz are abundantly visible, but besides, is curiously full of rounded lumps of quartz and quartzite about an eighth of an inch long, with transverse diameter less. It contains also, quadrangular crystals of feldspar from one-fourth to one-half inch in length. This mass embraces plenty of granulite intrusions. It extends a distance of thirty feet. It embraces a mass (dike-like) of granulite which in parts contains an abundance of excessively fine scales of mica.

Rock 133. Porphyritic mica schist.

Other irregularly intruded masses are abundant and some of them consist of very fine feldspar and quartz, with very few small scales of mica.

8. Mica schist, fine and well characterized, continuing sixteen feet, and becoming a fine hornblendic mica schist. Then, with obscuration of separate grains of hornblendic (or augitic) material it passes into a diabase-like rock.

9. Diabase-like rock — or perhaps a mere graywacke, nineteen feet. It is intersected by many dikes and veins of fine granulyte and fine syenite — though the dark mineral in the latter may be hydromica or viridite.

10. Mica schist, very fine. Mica seems to be muscovite. Rock variable like all the others — passing to a graywacke aspect and then distinctly a muscovitic schist. All profoundly intersected by dikes and veins of greenish granulite. Continues twenty-five feet. Stops at a dike eight inches wide.

11. Mixed mass of hornblende schist and intrusions of granulyte and syenite. Inextricable confusion. Also large inclusions of porphyritic syenite.

12. Syenite, typical, with coarse hornblende, including masses of hornblende schist, 12 feet.

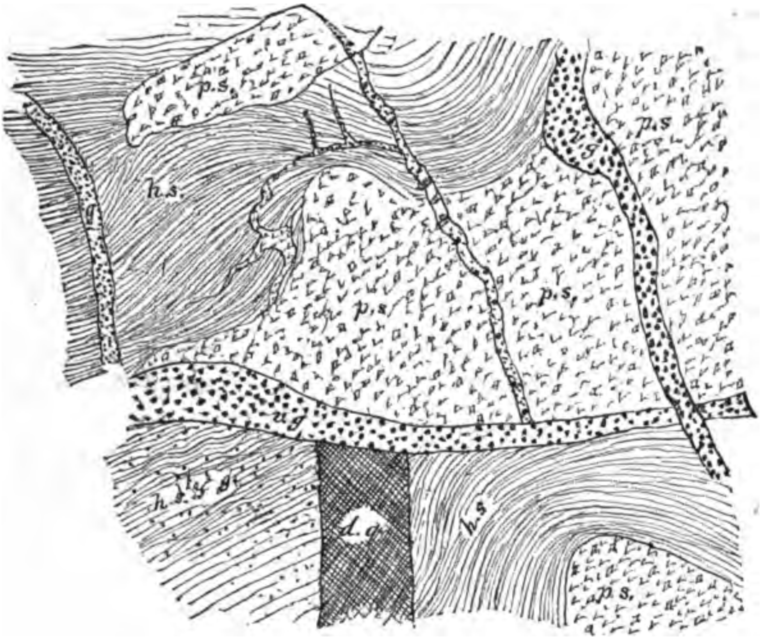

Fig. 34 *Confused mass of schist, syenite granulite and porphyritic syenite on Geology I. Farm Lake.*

g. granulite; h. s. hornblende schist; p. s. phorphyritic senite; q. quartz; v. vitreous; d. dun.

13. Mica schist, intermingled as usual.

14. An exposure which is fundamentally hornblende schist — in places muscovitic — but contains imbedded pebbles of various kinds, giving it in places the appearance of a plum-pudding. These pebbles are mostly rounded, and among them I recognize:

a. Semivitreous granular quartzite.

b. Granular quartzite.

c. Fine syenite.

d. Syenite with scattered large grains of quartz.

e. Smoky quartz.

The exposure is intersected by a two inch dike of beautiful diorite, consisting of hornblende and a pale greenish feldspar. Also by veins of quartz. The conglomeritic character is confined to a distance of about 12 feet.

I have given this little island quite a detailed and patient ex-

amination. Fundamentally it appears to be mica-hornblende schist, but in a state of unstable equilibrium, sometimes turning to mica schist, and at others to hornblende schist.

But the whole mass was formed in immediate proximity to syenites and granulites, and these have been injected into it with infinite diversity of form, direction and volume. The schists and the other rocks are kneaded together, and in places the attrition of the parts produced true conglomeritic constituents. Afterward, when the formation became somewhat consolidated, it was rent by firm-walled fissures which were filled by the various dike materials—granulyte, fine syenite and dioryte.

This little island, not even inditated by the land surveyors, possesses remarkable interest geologically, a wonderful concentration of rock varieties, geological incidents and forms, and well deserves the name of Geology island.

HALT 236. S. E. ¼, N. E. ¼, S. 34, T. 73-11. Porphyritic syenite with dikes of dusky vitreous quartz and coarse granulite—appearing to be a continuation from Geology island.

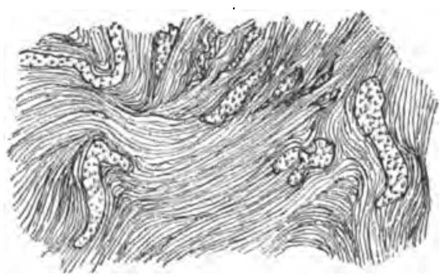

Fig. 35. Hydromica schist warped around masses of granite, Halt 240, Farm Lake.

HALT 237. S. E. ¼, N. E. ¼, S. 34, T. 63-11. On the shore mica schist 20 feet; then porphyritic syenite 20 feet; then mica schist.

HALT 238. Very near last. Muscovite schist standing vertically.

HALT 239. 20 rods from last. Mica schist passing into graywacke.

HALT 240. Centre of N. W. ¼, S. 34, T. 63-11. A curious exhibition. Greenish hydromica schist warped and twisted in various ways, containing ragged masses of granite and granulyte which, on weathered surfaces of the formation, project from one to six inches above the schist. The longer axes of these fragments are conformable with the schist, even bending where the schist bends, and thus proving that the included masses were plastic at the same time that the schist was plastic, and showing that the whole mixture was, in its various constituent parts, subjected to softening conditions. See figures 35 and 36.

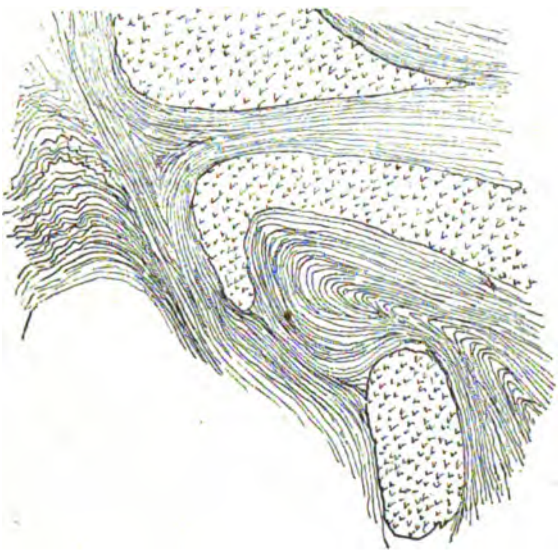

Fig. 36 Hydromica schist and granite both showing indications of plasticity at Halt 240, Farm Lake.

Rock 134. Hydromica schist, some of which shows the bent included granite.

HALT 241. A little north of 240. Very compact biotite hornblende schist, extensively intersected by dikes of fine granite.

HALT 242. Near centre N. E. ¼, S. 34, T. 63-11. Fine com-

pact syenitic gneiss, with some mica—related to the fragments included at Halt 240. Portions of this are twisted together with mica schist, and some of the latter is porphyritic, like that on Geology island.

HALT 243. N. W. ¼, N. E. ¼, S. 34, T. 63-11. Graywacke schist, striking N. 70° E., and dipping N. 88°, interbedded with dike-like beds of quartz, of which I count 19 in the space of 12 feet. In the midst are also large masses of fine hard gneiss.

§ 12. KAWISHIWI RIVER.

This is a winding, irregular stream which drains Birch and other lakes to the eastward, interrupted by frequent rapids, and, in the intervening regions, swelling into little lakes, some of which are worthy of special names. My personal explorations extended up this chain of waters only to the boundary of Range 10. The geology of the vicinity is completely accessible. It occupies a zone of mica schists half or three-fourths of a mile north of the syenite.

HALT 244. S. W. ¼, S. E. ¼, S. 27, T. 63-11. Mica schist, very compact on the north, and shelly on the south.

HALT 245. S. W. ¼, S. E. ¼, S. 27, T. 63-11. Mica schist, very compact, exactly like last.

HALT 246. S. E. ¼, S. E. ¼, S. 27, T. 63-14. Mica schist, like last two Halts.

HALT 247. S. W. ¼, S. E. ¼, S. 27, T. 63-11. Mica schist, but more silicious than last.

HALT 248. N. W. ¼, N. E. ¼, S. 34, T. 63-11. Compact mica schist passing to fine gneiss.

HALT 249. N. E. ¼, N. E. ¼, S. 34, T. 63-11. Mica schist, quite characteristic.

HALT 250. N. E. ¼, N. E. ¼, S. 34, T. 63-11. Mica schist, like last.

HALT 251. N. E. ¼, N. E. ¼, S. 34, T. 63-11. Mica schist, weathered somewhat columnar.

HALT 252. N. W. ¼, N. W. ¼, S. 35, T. 63-11. Compact mica schist.

HALT 253. N. W. ¼, N. W. ¼, S. 35, T. 63-11. Compact mica schist.

HALT 354. N. W. ¼, N. W. ¼, S. 26, T. 63-11. Island and rapids. Compact mica schist. This is the narrows, and the

stream makes a descent over rapids. Here is a portage of about 20 feet across an island. The lake to the east we call Friday lake.

HALT 255. N. W. ¼, N. W. ¼, S. 35, T. 63-11. Near section line. Very compact mica schist in vertical cliff 25 feet high.

HALT 256. S. W. ¼, S. E. ¼, S. 26, T. 63-11. On island. Mica schist quite characteristic. Strike N. 72° E. Dip N. 65°.

HALT 257. S. E. ¼, S. E. ¼, S. 26, T. 62-11. Graywacke schist with a little mica.

HALT 258. S. E. ¼, S. E. ¼, S. 26, T. 63-11. Graywacke schist, some of it with a little hornblende.

HALT 259. S. W. ¼, S. W. ¼, S. 25, T. 63-11. Compact mica schist interbedded with graywacke schist. Present again the multitude of small, ill-defined silicious veins seaming the schist. The graywacke schist contains much feldspar in many distinct grains in undefined outlines.

HALT 260. S. W. ¼, S. W. ¼, S. 25, T. 63-11. Compact mica schist.

HALT 261. S. W. ¼, S. W. ¼, S. 30, T. 63-10. Rapids. Enormous outcrop of syenite with little quartz, a reddish feldspar and large crystalline fragments of hornblende. The formation is intersected by streams of fine syenite, the hornblende crystals in which lie with their longer dimensions paralled with the stream. In the main formation the large fragments of hornblende—some of which are ⅝ of an inch long—lie with their longer dimension in the common direction.

HALT 262. Centre S. E. ¼, S. 26, T. 63-11. Silicious mica schist. Many quartz veins. Strike E. and W. Dip about vertical. Some parts are intensely hard, and the abundance of the feldspar makes it a gneiss. The weathered surface of this looks like a diorite or diabase, the mica being hydromica and very inconspicuous. Perhaps this part, though so hard, may be pronounced one of the varieties of that heteromorphous rock, graywacke.

HALT 263. N. side S. E. ¼, S. 26, T. 63-11. Mica schist mass; but I judge from the attitude that it has been displaced, though certainly not far.

HALT 264. Near centre S. 26, T. 63-11. Mica schist. The quartz is very fine and there are small disseminated grains of feldspar. I suspect the micaceous constituent begins to be sericitic.

HALT 265. N. E. ¼, S. W. ¼, S. 24, T. 63-11. Here the mica-

ceous constituent is less; the feldspathic is more abundant and forming a groundmass, making a rock approaching a felsitic schist, in places. In other places it is more micaceous, but contains imbedded fragments of syenite and quartz veins.

LT 266. N. E. ¼, S. E. ¼, S. 26, T. 63-11. Island. Same as last, with a further remove from mica schist. Rock presents a massive exterior, but broken specimens show a bedded structure. I see no indications of mica or quartz. It is no more a graywacke than a mica schist. Glacial striae S. 29° W.

HALT 267. S. E. ¼, S. W. ¼, S. 26, T. 63-11. The rock exhibits a recession toward mica schist. It is still hard and presents, as far as I can judge, in the main, a sort of graywacke constitution, with a diabasic aspect; but there are courses of a pale brownish or whitish mica-like mineral which is soft and inelastic, and I therefore designate the rock sericitic graywacke schist.

HALT 268. S. E. ¼, S. W. ¼, S. 26, T. 63-11. Sericitic graywacke schist.

HALT 269. S. W. ¼, S. W. ¼, S. 26, T. 63-11. North side of rapids. Mica schist very compact.

HALT 270. N. E. ¼, N. W. ¼, S. 34, T. 63-11. Mica schist characteristic.

§ 13. BASSWOOD LAKE.

Next to Vermilion lake in extent of surface, Basswood lake presents similar irregularity of outline, with numerous deep bays, but with fewer islands, and accordingly broader expanses of water. It lies on the national boundary, and some of its deep bays protrude into Canadian territory. Its extension along the boundary is about 14 miles. It stretches from the eastern part of T. 65-9 to the western part of T. 65-10. From the boundary in T. 65-10, one of its arms extends southwestward into the centre of T. 64-11. It may be conveniently divided into five great bays or arms, for purposes of nomenclature. Arm I lies chiefly in sections 11, 12, 13 and 14, of T. 64-10. Arm II straggles through the northwestern portion of the same town, covering more or less of sections 5, 6, 7, 8, 9, 17 and 16. Arm III covers sections 3, 4, 9 and 10. Arm IV stretches far southwestward toward Fall lake, covering portions of sections 6, T. 64-10 and 1, 2, 11, 12, 13, 14, 15, 22, 23, T. 64-11. Arm V lies parallel with this on the northwest, and covers portions of sections 36 and 35

in T. 65-11, and of sections 1, 2, 3, 4, 8, 9 and 10 in T. 64-11. In continuation of the axis of Arm IV is that of Arm VI, which penetrates 8 miles beyond the remotest point of the national boundary, near Northeast Cape. The whole length of water, from the northern extremity of Arm IV to the southern extremity of Arm IV, is about 18 miles. On the American side it extends into six different townships.

No attempt will be made to give a physiographic description. The country which it occupies contains many rounded bosses and ranges of hills, some of which attain probably, an elevation of two hundred and fifty feet. The immediate shores along the American side, are generally rocky, and, where not denuded by fire, are covered by a medium-sized growth of pines, poplars, fir, spruce and white birch. Some of the bays abound in wild rice, and this is especially the case with Bays I and II. To these the Indians habitually resort in the season. The lake is frequently swept by winds, and as there are in places expanses of four to ten miles of watery surface, canoe navigation becomes difficult and sometimes perilous.

From Fall lake there are three customary routes of approach to Basswood. Something depends on the direction of the intended voyage after reaching the lake. If one purposes proceeding eastward along the boundary, or southward into Newfound and Moose lakes, it is customary to proceed to the extremity of Fall lake, in S. W. ¼, S. 36, T. 64-11, and pass by three portages to Saturday and Urn lakes, into Arm II. If it is intended to go westward along the boundary, it is customary to pass over the rapids out of Fall lake into Newton lake. These are in the S. W. ¼, S. 3, T. 63-11. Newton lake leads by Pipestone rapids, S. W. ¼, S. 22, T. 64-11, into Arm IV of Basswood lake. From this the journey may be continued westward, or, if the long portages by the first route eastward are to be avoided, an easy portage of half a mile leads from Arm IV, near the centre of S. 6, T. 64-10, to Arm II; and from the northeasterly point of this another easy portage leads to the nearest point of Arm III, whence three miles of canoe-travel lead to Arm I as before.

The description of the geology of Basswood lake, so far as observed by me, will proceed from Fall lake over the portages into Arm I and thence eastward. It will then return to Fall lake and pursue the course down the rapids, through Newton lake and along the east shore of Arm IV, and thence crossing its

mouth to the main shore westward toward Crooked lake. Arm V was not visited by the writer, nor the west shore of Arm IV.

HALT 401. S. W. ¼, N. E. ¼, S. 36, T. 64-11. Saturday lake. Chloritic argillite.

HALT 402. S. W. ¼. N. W. ¼, S. 36, T. 64-11. Compact sericitic schist— parts felsitic.

Rock 174. Compact sericitic schist.

HALT 403. S. W. ¼, N. E. ¼, S. 36, T. 64-11. Sericitic schist. Strike N. 81° E. Dip vertical.

HALT 404. N. E. ¼, N. E. ¼, S. 36, T. 64-11. Bluish-green rock, especially on weathered surfaces; fundamentally a sericitic argillitic chloritic schist; but on the weathered exterior looking somewhat like a conglomerate, in consequence of the presence of many masses of different constitution from the matrix, but only partially isolated from it. Some of these masses contain disseminated grains of quartz, and are of fine, light color, but on being broken, are greenish, schistose, and little distinguishable from the general matrix. This rock is considerably like that at Halt 318.

Rock 175. Sericitic chloritic argillite.

HALT 405. N. W. ¼, N. W. ¼, S. 31, T. 64-10. Sericitic argillite.

The portage out of Saturday lake starts from a point near the intersection of the town line and north line of S. 31. The portage to Urn lake is dry and plain. The forest is largely white birch, and there are evidences of much Indian occupation.

HALT 406. Centre N. E. ¼, S. 36, T. 63-11. Sericitic schist, argillitic.

HALT 406 *bis*. N. E. ¼, S. W. ¼, S. 30, T. 64-10. Urn lake. North of entrance to lake. Ground completely covered with syenite boulders and fragments.

HALT 407. N. E. ¼, N. E. ¼, S. 30, T. 64-10. Sericitic schist, rather compact.

HALT 408. S. E. ¼, N. E. ¼, S. 30, T. 64-10. Silicious sericitic argillite.

Rock 176. Silicious sericitic argillite.

HALT 409. N. E. ¼, N. E. ¼, S. 30, T. 64-10. Sericitic schist compact, warped, with many veins of granulyte.

HALT 410. Four rods north of Halt 409. A boss of rock which I incline to consider doleryte. It is dark gray, fine grained with glistening points, crystals of calcite and a groundmass of a dark mineral likely to be labradorite. There is a breadth on the shore of twenty-five feet, and I trace it back about thirty feet. In

some parts the calcite is disseminated in the form of amygdules, and on weathered surfaces they are dissolved out.

Rock 177. Doleryte.

Rock 178. Amygdaloid.

HALT 411. N. W. ¼, N. W. ¼, S. 29, T. 65-10. Great mass of fragments of porphyritic granulyte. Rock apparently not far from outcrop. Most of the rock material is feldspar; but there are many disseminated grains of quartz, and many such grains are imbedded in the feldspar individuals, as if the feldspar had grown around them and included them.

Rock 169. Porphyritic granulyte.

In some parts are very fine scales of a whitish mica-like mineral. Close by are great flat masses of greenish sericitic mica schist. Also fragments of coarse muscovite schist.

HALT 412. N. E. ¼, N. W. ¼, S. 29, T. 64-10. Sericitic schist varying to silicious sericitic schist. Strike N. 85°. Dip 75° N.

This lake is very shallow in the eastern part, and the mud is four to eight feet deep. The portage begins at the foot of a little bay filled with aquatic plants, and one can not get the canoe within thirty feet of solid land — and that is a swamp.

HALT 413. N. W. ¼, N. W. ¼, S. 20, T. 64-10. On portage. Very fine dark-colored mica schist, with an obscure hornblendic aspect.

Rock 180. Fine mica schist.

HALT 414. N. W. ¼, N. W. ¼, S. 20, T. 64-10. Basswood lake. Outcrop at end of portage. Rock which seems to be either diabase or norite.

HALT 418. S. E. ¼, S. E. ¼, S. 17, T. 64-10. Rock with hornblende and feldspar, and without quartz — dioryte schist. Some of the shining diallagic crystals can scarcely be distinguished from biotite.

HALT 417. S. E. ¼, S. E. ¼, S. 17, T. 64-10. Hornblende schist, compact and fine, with indications of minute mica scales. The amount of quartz is slight, and portions may be more correctly indicated as dioryte schist — or perhaps hyposyenite schist.

HALT 416. S. W. ¼, S. W. ¼, S. 16, T. 64-10. Hornblende schist very compact and fine, with a slight indication of minute mica scales.

Rock 181. Hornblende schist.

HALT 415. N. W. ¼, N. W. ¼, S. 21, T. 64-10. Essentially

fine mica schist, but different parts are in different conditions. Some is characteristic muscovite schist, compact, with flat lenticules of quartz; other parts are still finer, and one only sees the mica particles under a lens by getting reflections of sunlight. The muscovite seems to be in a *nascent state*.

The whole formation is considerably warped and plicated, but there are no granite veins seen, though the exposure is an acre or so. Strike N. 67° E. Dip N. 75°.

HALT 419. S. E. ¼, S. W. ¼, S. 1¼, T. 64-10. Hornblende and feldspar — probably triclinic. It may be dioryte schist, but very massive. The dark mineral may, however, be augite.

HALT 420. S. E. ½, S. W. ¼, S. 16, T. 63-14. Distinctly schistose, but finer-grained than the last, and approaching the character of a graywacke.

HALT 421. Near centre of S. 16, T. 64-10. Mica schist and granite.

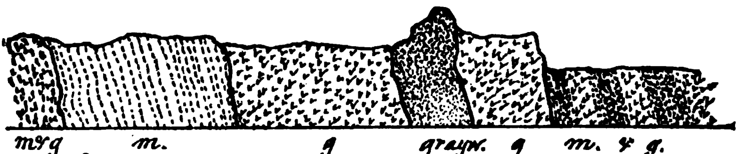

Fig. 37. Alternations of granitoid gneiss and mica schist, Halt 421, Basswood Lake.

The granite is a hydromica-biotite granite. It alternates with the muscovite-biotite schist in thick beds as shown in Fig. 37; and in places is intertwisted in an intricate fashion.

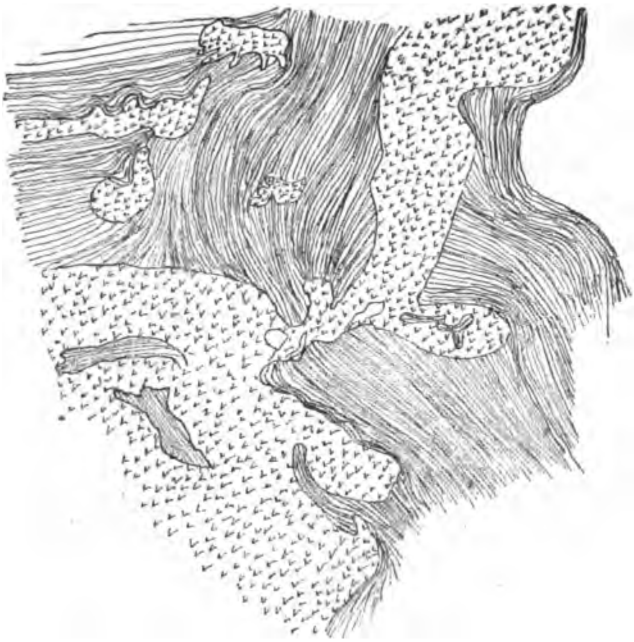

Fig. 38. Intertwisting of granite and mica schist, Halt 421, Basswood Lake.

The granite is not properly in the form of veins or dikes, and the schist is not altered where in contact with the granite, or even embraced in it.

At the beginning of the shore outcrop, the granite and the mica schist are intimately interlaminated for a space of four or five feet.

Back from the shore is a hill seventy-five feet high, composed of syenite and a fine schist, in which the fine dark mineral is probably hornblende, but may be biotite. In other specimens it is certainly biotite.

HALT 422. S. W. ¼, N. E. ¼, S. 16, T. 64-10. Biotite schist and hydromica-biotite granite.

HALT 423. N. E. ¼, N. E. ¼, S. 16, T. 64-10. Syenite.

HALT 424. N. E. ¼, N. E. ¼, S. 16, T. 64-10. Syenite, but with a more hornblendic syenitic gneiss imbedded in fragments.

Rock 182. Syenite—two varieties.

Some of the dark mineral in the included fragments is biotite in part.

HALT 225. N. E. ¼, N. W. ¼, S. 15, T. 64-10. Cliff fifty feet high. Arm I of Basswood lake. Mica schist passing on one hand into graywacke schist and on the other into gneiss.

Rock 183. Graywackenitic mica schist.

Rock 184. Mica schist passing to gneiss.

HALT 426. N. W. ¼, N. W. ¼, S. 15, T. 64-10. Biotitic gneiss.

HALT 427. Centre S. E. ¼, S. 10, T. 64-10. Island. Syenite—some with red orthoclase—some with lumps of a more hornblendic gneiss included.

HALT 428. N. E. ¼, N. E. ¼, S. 10, T. 64-10. Biotite granite.

HALT 429. S. E. ¼, N. E. ¼, S. 11, T. 64-10. Syenite—some with red orthoclase, some with white.

HALT 430. S. W. ¼, S. W. ¼, S. 12, T. 64-10. Syenite, typical; but it incloses some masses of biotite schist, which weather green and fibrous. Portions of the syenite are also replaced by biotite gneiss.

[Observation. This point is thirty-eight miles in a straight line from Tower; and yet we hear with great distinctness, the blasting in the iron mines. The sounds are like those of very heavy thunder from below the horizon.]

HALT 431. S. E. ¼, S. E. ¼, S. 11, T. 64-14. Syenite, typical.

HALT 432. S. W. ¼, N. E. ¼, S. 14, 64-10. Island. Fundamentally a schist which is very fine and so nearly intermediate between biotitic and hornblendic that I can not, with a pocket lens, assign its position. One bed two feet wide, is elegantly banded black, red, green and gray. The black is undoubtedly hornblendic; the red is orthoclasic; the green is epidotic, and the gray is graywackenitic.

Rock 185. Mica schist with colored bands.

Some parts of the formation are distinctly a hornblendic schist. The bedding is distinct. Strike N. 68° E. Dip 30°.

HALT 432 *bis*. N. E. ¼, N. E. ¼, S. 14, T. 64-19. Very fine mica schist, but much like the rock at Halt 432. Strike varies in a rod from N. 68° E. to N. 78° E.

HALT 433. S. E. ¼, N. W. ¼, S. 14, T. 64-10. Argillitic chloritic sericitic schist.

HALT 434. S. W. ¼, S. E. ¼, S. 15, T. 64-10. In the marsh contiguous to a little lake which I call Lost lake.

I reached this lake in the effort to reach Wood lake on the way to Moose lake. We found no portage in that direction. We pushed up a sluggish, winding creek about a mile in a straight line. Retreated with the intention of reaching Moose lake through Carp and Newfound lakes. Wild rice is very abundant in all this vicinity.

HALT 435. S. W. ¼, N. W. ¼, S. 12, T. 64-10. Hornblende rock, but the outcrop is small, and syenite may lie on either hand.

HALT 436. S. W. ¼, N. W. ¼, S. 12, T. 64-10. Island. Syenite, but the exposure is slight, fragments cover the ground.

HALT 437. Centre of S. 12, T. 64-10. Ground strewn with angular fragments of syenite.

HALT 438. N. W. corner N. E. ¼, S. 12, T. 64-10. Syenite. Some of the outcrop along this shore is horizontally bedded in beds two to three inches thick, which separate like strata.

Rock 186. Syenite from Halt 438.

HALT 439. S. E. ¼, S. E. ¼, S. 1, T. 64-19. Syenite, not bedded.

HALT 440. Close by the town line. Syenite horizontally bedded, and looking quite schistose.

All along this shore the syenite proves to be horizontally bedded — in some places the beds only an inch thick.

HALT 441. S. W. ¼, N. W ¼, S. 6, T. 64-9. Bedded syenite giving a slaty impression; but examination shows that the dividing planes are joints. The leaves range from half an inch to two inches in thickness.

Next eastward follow four or five miles of shore line without any outcrop. The beach, however, is covered with angular fragments of syenite.

HALT 445. S. E. ¼, S. E. ¼, S. 33, T. 65-9. The numerous shore fragments are mostly, as heretofore, of syenite, having whitish feldspar, but there are some with masses of hornblende rock, and I preserved one piece in which prisms of hornblende are pretty well preserved.

Rock 187. Syenite with crystalized hornblende.

HALT 443. S. W. ¼, S. E. ¼, S. 34, T. 65-9. Bedded syenite as before. Also massive feldspar and white quartz plentiful. I find fragments consisting of alternate layers of red syenite with little hornblende, and dark syenite with much hornblende and red orthoclase. Both are evidently finely laminated. I find also fragments with hornblende schist in contact with syenite.

Also fragments of very coarse granulite. Also fragments of muscovite schist.

Rock 188. Syenite from Halt 443. Thin scale—not bedded.

Back from the shore a quarter of a mile, the syenite rises in a hill fifty feet high. Here it embraces masses of other sorts of syenite and schists.

Rock 189. Hornblende schist embraced in the syenite last mentioned.

HALT 444. N. W. ¼, S. E. ¼, S. 30, T. 65-9. Island. We find no rocks in place. The beach is lined with very large fragments of the usual syenite. I see also some large slabs of biotite schist.

Walked around the island but found no outcrop, though I am sure the syenite is near. The schist fragments do not appear frequently except on the south side.

HALT 445. N. E. ¼, S. E. ¼, S. 34, T. 65-9. Horizontally bedded syenite.

HALT 446. S. W. ¼, N. E. ¼, S. 25, T. 65-9. Syenite, some with reddish feldspar.

HALT 447. Centre of S. E. ¼, S. 35, T. 65-9. Syenite, but not so massive and homogeneous as heretofore. It is compact, felsitic, with a disposition to bedding with a steep dip N. E. Also some sericitic matter, as if preparing to become a schist.

HALT 448. S. W. ¼, S. E. ¼, S. 39, T. 65-9. Syenite more massive than last, and less felsitic, but mostly less granular than the syenite seen during the day.

HALT 449. S. E. ¼, S. E. ¼, S. 35, T. 65-9. On the beach, alternating beds of gneiss, dioryte schist, granulyte, fine biotite schist wrapped around lumps of common syenite. Strike N. 20° E. Dip 50°.

Further back the formation is somewhat massive syenite, but with a bedded aspect.

HALT 450. N. E. ¼, N. W. ¼, S. 2, T. 64-9. The syenite here is gneissoid.

HALT 451. N. W. ¼, N. W. ¼, S. 2, T. 64-9. Mass very large but detached. It is a fine example of interbedding of schists and gneisses with included masses of syenite.

HALT 452. Near centre, S. 2, T. 64-9. A fine exhibition of the transition from gneiss to schist. The outcrop is fifty feet long and all distinctly bedded. The schists are predominantly hornblendic, weathering green and bluish. Strike N. 80° E. Dip?

Here are alternating beds of the following rocks:

Syenitic gneiss and syenite.

Hornblende schist.
Granulyte schist.
Chloritic schist.
Biotite schist.

The schist beds are in part limited in length — in part continuous across the exposure — warping around lumps of syenite when they are not in bedded form. The interbedding of the syenite and schists is, in places, so intimate that the rock is a visible mixture of the constituents of both, and both kinds of rock lose their identity.

Nothing can be more evident than that the syenite and schists were formed contemporaneously and under the same conditions — whether igneous or sedimentary — but it appears that masses of older syenite existed, from which fragments were separated to mingle with the forming bedded terrane. But the older syenite was not necessarily quite solid; it may have been aqueo-igneously plastic.

Transitions of this character between the syenite and the schists are little favorable to the theory that they belong to two different Great Systems.

Rock 190. Specimens illustrating the transition from syenite to schists.

The "chloritic schist" is mostly confined to thin partings. The biotite is mostly mixed with hornblende.

This locality is near the eastern limit of Basswood lake. The course of a few following observations is westward, touching some of the northern shores of the same bays.

HALT 630. N. E. ¼, N. E. ¼, S. 2, T. 64-9. Island. Syenite with pink feldspar.

HALT 885. Island north of point in S. 35, T. 65-9. Syenite.

HALT 886. One-third of a mile west of Halt 885. Syenite. This is a good medium-grain, typical syenite, with the three constituents clearly defined and in about equal proportions. Very suitable for constructions.

HALT 887. By three logs cabins, on a large island lying in Section 2, T. 64-10. Syenitic gneiss and schist interbedded The islands and main shore northwest of this are occupied by syenitic gneiss. Diorite occurs in the northeast corner of Section 4, T. 64-10.

HALT 888. N. W. ¼, S. 4, T. 64-10. At entrance to terminal bay of Arm 4, Basswood lake. Syenitic gneiss and mica schist. The opposite shore of this bay is syenitic gneiss.

A portage leads from near the head of this bay northwest to a bay belonging to Arm II. It is very wet for a few rods, then elevated and dry for a third of a mile.

HALT 889. Near centre of S. 5, T. 64-10. Syenitic gneiss and mica schist interbedded.

An island in the northern protuberance of Arm II is of mica schist, and the same occurs on the point of main land immediately south of it; while the main land northwest is dioritic.

The course of the observations now returns to the outlet of Fall lake at the rapids.

HALT 631. N. W. ¼, N. W. ¼, S. 3, T. 63-11. At the rapids. A bank of decomposing sericitic schist, appearing like mere drift.

The rapids convey enough water to permit a canoe to be guided down without portaging, but the operation is difficult at time of low water.

HALT 632. S. W. ¼, N. W. ¼, S. 34, T. 64-11. Newton lake. Very compact chloritic schist on the beach; adjoining, further back, chloritic schist weathering green, and with veins of quartz; and still further back, on the hillside, a conglomerate looking chloritic schist containing many veins and lumps of quartz, and detached, angular, elongated fragments of the same sort of rock, but a little harder. The rock, accordingly, weathers very rough. Strike obscure—seems to be N. 12° E. Dip about vertical.

HALT 633. Centre N. W. ¼, S. 34, T. 64-11. On the shore is a rugged mass, distinctly schistose but composed largely of a mineral of a dull green color, and lamellar crystallization resembling what I called augite on White Iron lake, but here more probably, massive chlorite. Strike N. 6° W?

Rock 252. Chlorite rock.

Back of this is compact, fine-grained, even aphanitic, sericite schist, quite silicious.

Rock 253. Aphanitic, silicious sericitic schist.

Some parts of this contain many imbedded specks which appear to be feldspathic.

Rock 254. Aphanitic sericitic schist with feldspathic specks.

The narrows in this lake are not rapids. Only a few bolders obstruct the passage.

HALT 634. N. W. ¼, N. E. ¼, S. 34, T. 64-11. Sericitic schist parts of which contain innumerable thin laminæ of reddish feldspar. Strike N. and S. Dip vertical. In some parts the feldspar is in the form of numerous small lenticules. In some places thin layers of quartz are interbedded.

Rock 255. Sericitic schist, Halt 634.

HALT 635. S. W. ¼, S. 26, T. 64-11. Compact sericitic schist, almost aphanitic, breaking into huge timber-like and plank-like pieces with striated surfaces suggesting the grain of wood. Strike N. 86° E. (?) Dip 60° N.

Some portions are filled with minute whitish shining scales, as if a mica schist were emerging into visibility.

Rock 256. Sericitic schist with minute shining scales.

These scales appear especially on the weathered surface. This part of the rock is silicious.

The formation contains masses of quartz and of granulyte.

HALT 636. N. E. ¼, S. 27, T. 64-11. Aphanitic, thin laminated sericitic schist. Strike N. 70° E. Dip N. 60°.

HALT 637. N. E. cor. S. 27, T. 64-11. Chloritic schist, thin laminated, easily crumbling into small scales. Weathers rough, with perforations. Strike N. 86° W. Dip vertical. Contains masses of quartz crystals and of feldspar, and in places is intimately interlaminated with them.

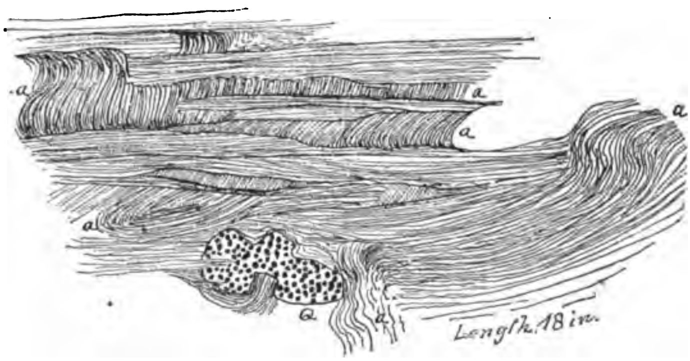

Fig. 39. Relations of chloritic schist and quartz masses at Halt 637, Newton Lake.
Q, quartz. a, a, a, chloritic schist warped and in places nearly faulted.

a a a, chloritic schist, warped.

Portions are considerably plicated, and the plications are sometimes almost faulted, as at *a a a*.

HALT 638. S. E. cor. S. 22, T. 64-11. Chloritic, sericitic, argillitic schist, with minute shining scales, as if about to become mica schist. Strike N. 82° E. Dip 82°.

Rock 257. Nascent mica schist.

At the northern extremity of Newton lake is a fine waterfall. The stream is 10 rods wide and the descent about 8 feet, in a broken plunge. It descends into a gorge bounded on the west by a precipitous rock wall, and on the east by a steep, earth-covered cliff, in which the "pipestone" is contained which gives name to these falls. These beds are exposed at the head of the falls, on the east side. They are not much valued for pipestone — being too silicious. They are intercalated in silicious schists and possess a bluish color. The main portage enters at the most northern point which a canoe can reach, and is not over 10 rods long, coming out at the foot of the falls.

HALT 639. At foot of falls. Outliers of the formation consist mostly of quartz; but this is in masses wrapped in chloritic schist, indicating that the replacing process seen begun at Halt 637 (see figure) has here been carried to extreme.

HALT 640. At expansion of the gorge on the east side. The bluff here is a mixture and alternation of syenitic gneiss, hornblende schist and chloritic schist.

Rock 258. Syenitic gneiss as above.

HALT 641. Foot of falls west side. Escarpment thirty feet high. Syenitic gneiss as at Halt 640. It is distinctly bedded in conformity with the schists of the region. It contains a chlorite constituent, and is interstratified with portions approaching chlorite schist. All the joints are lined with a film of chloritic schist.

Rock 259. Syenitic gneiss as above.

Twenty feet further down, the gneiss is succeeded by fine compact graywacke schist containing in places, mica scales.

Rock 260. Graywacke schist as above.

But between this and the gneiss is an intermediate condition in which the schistose and gneissic constituents appear commingled in a fine magma, but not homogeneously mixed, since the laminar coloration reveals the contrasts among them.

Rock 261. Magma as above.

The graywacke mica schist described has a strike N. 65° E. and dip N. 78°.

Rock 262. Small specimen showing 261 in contact with the gneiss.

Back from the shore thirty feet and across the strike of the formation and back of the mass of gneiss (Rock 259) occurs an intercalation of micaceous hornblende schist as below.

Rock 263. Micaceous hornblende schist.

HALT 642. S. W. ¼, N. W. ¼, S. 22, T. 64-11. Syenitic gneiss and chlorite as at Halt 640.

HALT 643. S. W. ¼, N. W. ¼, S. 42, T. 64-11. Gneiss containing considerable chlorite and weathering green. The longer axes of the dark minerals all lie in one direction. The formation is intersected by quartz veins and granulyte veins — also contains irregular lumps of granulyte. Strike N 80° W.

HALT 644. S. E. ¼, S. 22, T. 64-11. We have here again micaceous hornblende schist on the north side, and syenitic gneiss on the south. The contact where seen is abrupt.

Rock 264. Micaceous hornblende schist as above.

HALT 645. S. E. ¼, S. W. ¼, S. 15, T. 64-11. Island. Chiefly syenitic gneiss, but it contains beds of hornblende schist. Also veins of quartz and of epidote.

Rock 265. Samples in which the constituents of syenite or hyposyenite are mixed with an equivocal dark mineral which is a condition of the hornblende (chlorite) found in included beds.

Examining further these curious lithological conditions, I find the main rock to contain little or no quartz and no hornblende. It is essentially a mixture of feldspar and chlorite, and might be called a chlorite hyposyenite in a gneissic state, but it should have a distinct name.

It is impossible to break the rock into standard specimen form, but I preserved twenty-five or more specimens in the best shape possible.

Postscript. A rock composed essentially of chlorite and feldspar, with a variable but subordinate quantity of quartz, is widely distributed along the national boundary. I have no doubt that it has been in a rough way designated as syenite, or even as granite, since it is simply granitic in general aspect. It is not, however, a granular rock, and appears to be largely composed of matter of the second order of consolidation (Fouqué and Michel-Lévy.) It has been fully established, however, that the chloritic constituent in crystalline rocks, is very frequently a transformation product from augite or amphibole. This formation may, therefore, have once been a diabase or diorite, and this opinion is favored by the contiguous and included beds of hornblende schist. It may prove that the feldspathic constituent is monoclinic, and thus the formation may originally have been a hyposyenite as at first suggested. But it is none of these now. Chlorite exists in place of amphibole or augite. We can

not designate a rock mineralogically for what it has been, but is no more. If composed of chlorite and feldspar we must name it with regard to its actual constitution.

Epidiorite, according to Gümbel, is a greenish rock containing amphibole, plagioclase and a subordinate quantity of augite, together with a chloritic constituent and some titanic iron. The rock in question does not sensibly deviate to a very material extent from epidiorite—even to the titanic iron, which, if not noticed at this Halt, was abundant enough in the immediate vicinity. Still the predominance of amphibole in true epidiorite is a divergence of some moment; and, as a similar rock frequently contains quartz as will be seen, it may well be doubted whether it belongs to the same group of geological causes. I still think, therefore, that precision of language requires for it a special designation.

When the rock contains quartz, it approaches the constitution of protogine, and such a rock when schistose, is the "chlorite gneiss" of Rath. The rock in question here is at least in places obscurely bedded and might perhaps be designated chlorite-gneiss.

The observations show a wide distribution of rocks having a general constitution as follows:

Feldspar, chlorite. Subordinately hornblende, quartz, menaccanite, etc. (Chlorite hyposyenite or epidiorite).

Feldspar, chlorite, quartz. Subordinately hornblende, biotite, etc. (Chlorite granite. When schistose, chlorite gneiss.)

HALT 646. S. 15, T. 64.11. Rock with the chloritic constituent reduced to a minimum. What remains is chiefly feldspar in which I detect occasional grains of quartz.

Rock 266. Chlorite granite—specimen of above.

Another part of the outcrop consists of fine hornblende-like schist, but very heavy and not characteristically hornblende. I suspect it consists of hornblende, menaccanite and a feldspar.

Rock 267. Menaccanitic hornblende schist.

The formation contains large lumps of coarse granulite and many quartz veins. The bedding is much plicated, but there is not enough uncovered to ascertain the strike. In another place the rock has a fine gneissic aspect, with strike N. 30° E. and dip N. 82°.

HALT 647. N. W. ¼, S. 23, T. 64-11. Rock fine crystalline dark-greenish schist. It at first glance appears like a hornblende schist or hornblende rock. Some surfaces appear to con-

tain biotite. I see no quartz. There is a small amount of a feldspathic matrix. The dark-greenish mineral I suspect to be essentially chlorite or augite.

Rock 268. Rock as above.

Immediately contiguous is a gneissoid rock in which the dark mineral is chlorite.

Rock 269. Chlorite gneiss.

HALT 648. N. E. ¼, N. W. ¼, S. 23, T. 64-11. Syenitic gneiss with much chlorite.

HALT 649. S. E. ¼, S. W. ¼, S. 64-11. Syenite gneiss with chlorite.

Rock 270. Syenitic gneiss with chlorite.

HALT 650. Near centre S. 14, T. 64-11. Island. Rock having the appearance of a conglomerate. But it is essentially a syenitic chloritic gneiss with the dark mineral represented mostly by a rusty powder, so that the formation is in a crumbling state.

This very probably represents the final transformation of a rock primitively amphibolic or augitic.

HALT 651. N. E. ¼, S. 14, T. 64-11. Disintegrating, syenitic gneiss, like last. Like the last it shows a rudely bedded structure in horizontal planes.

HALT 652. Near centre S. 14, T. 64-11. A schist which is perhaps a graywacke, though it much resembles the rock at Halt 647. It has more of the feldspathic groundmass. This holds thin scales which impart a waxy translucency. In some parts of the outcrop the feldspar is accumulated in small granules. In other parts the feldspar is wanting, and the dark green mineral occurs in crowded folia which are inelastic, and some of them are silvery in lustre. I take all these for chlorite.

Rock 271. Chlorite schist last mentioned.

In immediate connection with these rocks I find regular chlorite gneiss, in which are included masses of the graywacke schist in which the feldspar exists in distinct granules.

HALT 653. S. W. ¼, S. 12, T. 64-11. Rotten chloro-syenitic gneiss.

HALT 654. S. 12, T. 64-11. Syenitic gneiss with chlorite, compact.

Rock 272. Chloro-syenitic gneiss.

HALT 655. N. W. ¼, S. W. ¼, S. 12, T. 64-11. Very fine fibrous micaceous hornblende schist, of dark color. If still finer it would be argillitic.

Rock 273. Micaceo-hornblende schist.

This is interbedded with various other forms of bedded rocks: chlorite rock, graywacke schist, and chloro-syenitic gneiss. Strike N. 50° E. Dip 70°. I note one chlorite bed 8 or 10 feet thick, and when broken it appears as if kneaded together with gravel, but the nature of the gravel can not be seen. The specific gravity is high.

Rock 274. Gravelly chlorite rock as above.

Many quartz and granulitic veins traverse the formation—many finely interlaminated layers of quartz.

HALT 656. S. E. ¼, N. W. ¼, S. 12, T. 64-11. Mica schist, quite characteristic, very fine, thin laminated, in part slaty and in part compact, much intersected by quartz veins, and with many included laminæ and lumps of quartz. Strike N. 43° E. Dip S. 80°.

Rock 275. Mica schist as above.

HALT 657.. S. E. ¼, S. W. ¼, S. 1, T. 64-11. Syenite with red orthoclase, but the dark mineral is chloritic. Contains also a glassy feldspar in small quantity.

HALT 658. Sec. 1, T. 64-11. Syenite with red feldspar.

HALT 890. Near centre S. 6, T. 64-10. Hornblende schist penetrated by syenite.

HALT 659. N. W. ¼, S. 6, T. 64-10. Mica schist fine, thin-bedded. Bedding much warped. Strike N. 40° E. Dip 75° S.

HALT 660. N. W. ¼, S. 6, T. 64-10. Chlorite schist with granules, like that interbedded at Halt 655; but here the granules are decaying and the weathered surface is covered with pits.

HALT 661. N. W. ¼, S. 6, T. 64-10. Entrance to straits. Syenite with white feldspar and a dark mineral fringed with chloritic green.

HALT 662. N. E. ¼, S. 6, T. 64-10. Compact syenite.

HALT 663. N. E. ¼, S. 6, T. 64-10. Syenite—usually so-called, but the dark mineral is chloritic.

HALT 664. N. E. ¼, S. 6, T. 64-10. Syenite with red feldspar.

HALT 665. S. W. ¼, S. 31, T. 65-10. Dioryte. Large fibrous crystals of hornblende imbedded in a matrix consisting of small grains of white and pale green feldspar.

Rock 276. Dioryte as above.

HALT 666. S. W. ¼, S. 31. T. 65-10. Syenitic gneiss of various aspect.

HALT 667. S. W. ¼, S. 31, T. 65-10. Syenitic gneiss, very distinctly bedded, including great masses of coarse chloritic syenite gneiss.

I followed a continuous outcrop around the cape for twenty or thirty rods, interested by appearances of greatly diminished dip. The formation embraces quite a succession of rocks: syenitic gneiss, chloritic gneiss, mica schist, hornblende schist, dioryte schist, and these in various states all warped in common or singly, and much disturbed by numerous veins of granulyte and quartz which intersect the other rocks in all directions.

The dip is exposed quite extensively, and varies from 10° to 40° north of east to nearly east.

HALT 668. N. E. ¼, S. E. ¼, S. 36, T. 65-11. Gneiss of various qualities, interbedded with diorite schist, and crossed by many veins of coarse granulite and of quartz. Strike N. 88° W. Dip N. 85°.

Some fifteen rods south, the strike is N. 88° E.

The dark mineral in this formation is mostly a bright, sharply outlined hornblende.

HALT 669. N. W. ¼, S. W. ¼, S. 31, T. 65-10. Syenite with red feldspar—considerably broken up and irregular, but an enormous outcrop. The same continues along this shore to the narrows.

HALT 670. At the narrows. Syenitic gneiss very massive and compact, with an abundance of red feldspar, causing the outcrop to appear distinctly red at a distance. That this is gneiss is shown by the position of the elongated dark mineral, by the intercalation of beds of hornblende schist, and by the general lack of uniformity in the aspects of the outcrop.

HALT 671. S. E. ¼, S. E. ¼, S. 30, T. 65-10. Syenitic gneiss, medium texture with red feldspar.

HALT 672. N. E. ¼, S. E. ¼, S. 3, T. 65-10. Syenitic gneiss. Texture varying from coarse to fine—some large orthoclase crystals. The bedding planes are distinct and in places somewhat crowded together. Strike N. 60° E. Dip 85° N. W.

HALT 673.* N. W. ¼, S. 29, T. 65-10. Syenitic gneiss with red feldspar, some portions containing very little hornblende. There are intercalations of hornblende schist, and even of muscovitic hornblende schist. Some beds contain iron and appear menaccanitic, with high specific gravity. Strike N. 60° E. Dip vertical.

Rock 277. Menaccanitic schist.

HALT 674. N. E. ¼, N. W. ¼, S. 29, T. 65-10. Syenitic gneiss, very distinctly bedded, with many intercalations of mica-hornblende schist. Strike N. 50° E. Dip vertical. The gneissic portions are also introduced in large masses around which the schists are wrapped.

HALT 675. S. W. ¼, S. W. ¼, S. 2, T. 65-10. Syenitic gneiss occurring in great sheets by which beds of schist are both intersected and inclosed.

HALT 676. N. W. ¼, S. W. ¼, S. 20, T. 65-10. Syenitic gneiss, fine, solid, massive and somewhat homogeneous. Strike S. 40° E. Dip vertical.

HALT 677. Here are the rapids or falls which mark the end of Basswood lake and the boundary. If I have my position correctly on the plat, the point is a mile east of the narrowest portion of the water indicated. The stream descends about 25 feet in the distance of 8 rods, and presents an interesting scene, even at this low stage of water.

The rock here is granitic and rather coarse. The quartz and feldspar exist in equal quantities. The dark mineral is much less in quantity, and is ill-defined. Occasionally it is mica—apparently biotite; some portions have a chloritic look, and other portions are apparently hornblende. The general structure of the formation is granitoid rather than gneissoid. Certainly it is not schistic, and it would not be possible to determine any strike.

HALT 730. S. W. cor. S. 29, T. 65-10. Basswood lake. Syenite gneiss and biotite schist. The gneiss contains little quartz, the schist a little hornblende and but little quartz. The mass is mostly gneiss. The schist occurs as fragments, not continuous as strata.

HALT 731. S. W. ¼, S. 22, T. 65-10. West side of the great promontory, in the narrows of Arm V. Rock chloritic and sericitic—some parts in thin splinters with a waxy translucence—fracture very uneven, weathering rough and somewhat craggy. Strike N. 30° E. Dip vertical.

Rock 294. Chloritic sericitic schist as above.

§ 14. CROOKED LAKE.

From Basswood this is reached through an irregular river along the boundary, broken by a succession of falls and rapids. The length of this connecting stream is about 11 miles, and the

length of Crooked lake about 18 miles. The shores of these waters are generally clothed with a scant forest containing Norway pines of moderate growth, some white pines, and many aspens and birches. A small species of oak is not unknown. Many shores however are lined by massive outcrops of crystalline rocks essentially syenitic and many bald knobs of syenite are seen rising in the background, sometimes glowing with a ruddy hue imparted by an abundance of red feldspar which assumes its striking color only after weathering.

HALT 678. N. E. ¼, N. E. ¼, S. 19, T. 65-10. Rapids beyond the falls out of Basswood lake. Biotite gneiss very well defined. Contains beds in which the materials are very fine and the biotite abundant, the rock approaching biotite schist, though the quartz is inconspicuous. Strike N. 65° E. Dip vertical.

Some portions are quite coarse and almost a pure granulyte.

HALT 679. Lower end of rapids, about 20 rods from Halt 678. The rock is a well-defined syenitic gneiss with a little biotite. It tends to separate into horizontal beds.

On an island opposite is the arrangement of rock structure shown in the following figure:

Fig. 40. Discordant bedding at Halt 679, on the boundary between Basswood and Crooked Lakes.

u, discordant bedding. The black lines and shading represent hornblende. The principal mass is gneissic. The hornblende is everywhere strewn in streaks. At h. h. h. the hornblende is excessive in proportion.

The black lines and shading represent hornblende. The principal mass is gneissic. The hornblende is everywhere strewn in streaks. At *h h* the hornblende is excessive in proportion.

The diagram covers 3 feet by 4 feet.

The whole descent of these rapids is about 25 feet in the space of 20 rods. But there is an island here, and a portion of the water descends by another rapid on the American side.

In a quarter of a mile the stream rapidly narrows and turns suddenly northward through a gorge about 30 or 40 feet wide. The water is swift and some boulders are seen in the bottom, but we guided the canoe safely, and on the return were able to paddle up the current.

Next, the stream turns suddenly westward, and in a quarter of a mile we come to Rapids No. 2 around which we make a port age on the American side.

HALT 680. N. W. ¼, S. 19, T. 65-10. Upper end of Rapids No. 2. Syenitic gneiss distinctly bedded. Strike N. 60° E. Dip vertical.

These rapids are a quarter of a mile long, and the total descent I would estimate at 59 feet.

HALT 681. N. W. ¼, S. 19, T. 65-11. Lower end of Rapids No. 2. Coarse biotite gneiss, with little mica. Strike N. 50° E. Dip vertical. Parts of it weathering very rough.

HALT 682. N. E. ¼, N. E. ¼, S. 24, T. 65-11. At rapids No. 3. A canoe will pass over these rapids. The rock exposure is biotite gneiss. Some parts, however, are very coarse and contain muscovite.

HALT 683. N. E. ¼, S. 24, T. 65-11. At rapids No. 4. These rapids are in two steps extending a quarter of a mile and descending about 10 feet in all. Rock distinctly gneissic, but with alternating beds of schist throughout. The dark mineral in the gneissic and the schistic beds is probably muscovite, since it is in part dark bronzy, though portions are nearly black. Strike N. 60° E. Dip vertical. The following view was taken while standing on shore:

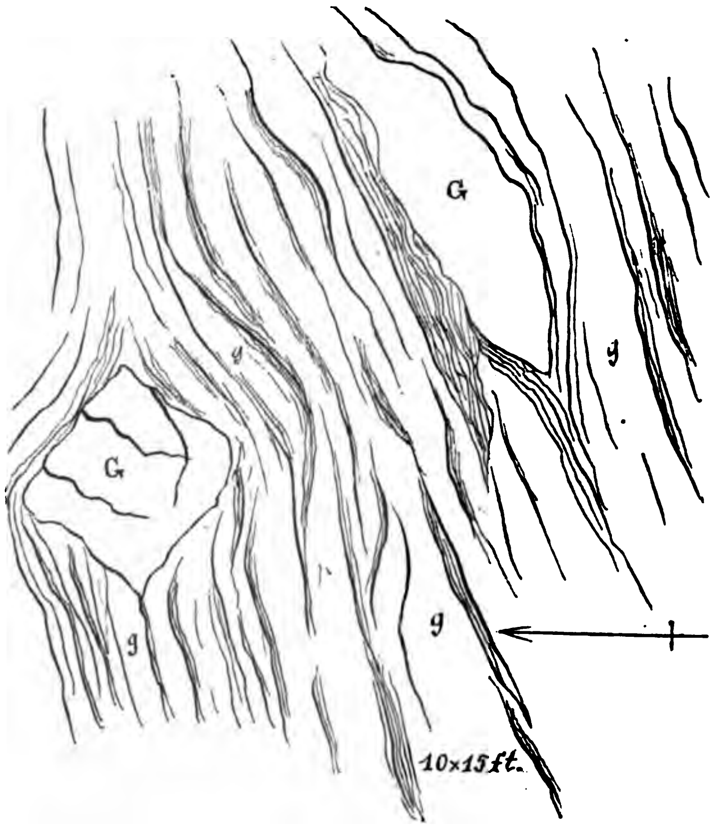

Fig. 41. View under the water at Rapids No 4, Halt 683, on the boundary below Basswood L.
The dark bands represent schists; the light spaces between are gneiss, g, g, g. Detached included masses are seen at G, G. — one with veins.

The dark bands represent schists, the light spaces between are gneiss.

Most of the rock, however, in this vicinity, for 30 rods, I find to be either a coarse granulyte with an excess of red orthoclase, or a syenitic gneiss with a little obscure hornblende.

HALT 684. N. W. ¼, S. E. ¼, S. 24, T. 65-11. Rapids No. 5. Gneiss with the dark mineral obscure, but interbedded with biotite gneiss.

HALT 685. N. E. ¼, N. W. ¼, S. 24, T. 65-11. Massive gneiss with very little of a dark mineral.

HALT 686. Centre S.W. ¼, S. 13, T. 65-11. Syenitic gneiss with very little and very obscure hornblende. Interbedded with beds of biotite schist 15 feet wide and under. These, however, as I ascertain, are not continuous strata, but apparently enormous chunks of a formation solidified and broken into fragments and plunged into a mass of plastic gneiss material.

HALT 687. N. W. ¼, S. 13, T. 65-11. Syenitic gneiss with much red feldspar. Enormous outcrops here and on all sides. The rock is very massive and the bedding planes are only occasionally revealed. The dark mineral exists in small quantity and is only obscurely hornblende. Strike N. 40° E. Main system of joints east and west.

HALT 688. On the line between sections 13 and 14, T. 65-11. Rapids No. 6. Here are the most furious rapids yet seen. The descent I estimate at 25 feet and the length of the rapids at a quarter of a mile. The stream is narrowed in places to 20 feet. A high bluff rises on the south and a ridge on the north. The pressure of the ice gorge here must be enormous. Accordingly, something like a lateral moraine borders the stream on the north side. It consists of rounded granitic debris appearing like boulders, many of them 4 to 6 feet in diameter piled in a rude wall 6 to 12 feet high.

The rock here is a syenite composed mostly of quartz and red feldspar; and part also a granite composed of quartz, white feldspar and a lustrous silvery mica. As I do not discover any bedding planes (though my opportunity for observation is limited) I set this formation down as syenite and granite. But it is my profound conviction that its history has differed little from that of the recognized gneisses; and with adequate opportunity for investigation, I could probably discover bedding planes.

Rock 278. Muscovite granite (silvery mica).

HALT 689. N. E. ¼, S. E. ¼, S. 14, T. 65-11. Syenitic gneiss distinctly bedded.

HALT 690. N. W. ¼, S. E. ¼, S. 14, T. 65-11. Gneiss, but thoroughly interbedded and kneaded with mica schist and hornblende schist. Strike N. 55° E.

HALT 691. S. W. ¼, S. W. ¼, S. 14, T. 65-11. Rapids No. 7. A mass of gneiss remarkably belted with sundry grades of coarseness and constituent proportions, and sundry schists. The schists in places occupy about half the mass. On the whole, however, I think one-sixth of the mass would be an approximate statement. The warping and wrapping are very remarkable—

both of the gneiss around the blocks of schist and of the schist around lumps of gneiss.

The rapids are very impressive and powerful, and the vast blocks of the formation which have been disjoined and thrown on side and weathered for ages render this spot an exceedingly instructive one.

HALT 692. N. W. ¼, S. 14, T. 65-11. Gneiss and schists intermixed as usual, but less of the schists.

HALT 693. Centre S. W. ¼, S. 11, T. 65-11. Gneiss and schists elaborately interbanded. Mica schist here has little feldspar and is friable with much quartz.

HALT 694. Centre S. 11, T. 65-11. Painted Castle. An enormous promontory 75 feet high, which presents on the east a vertical wall a quarter of a mile long and 50 or 60 feet high. It is by far the most impressive and interesting rock view which I have seen in Minnesota. The façade of this vast castle-like structure is broken into towers and wings, overhanging outlooks and recessed porticoes. The entire mass is distinctly schistose, and the beds stand vertically. The architectural suggestions are further increased by the vertical striped coloration of the successive beds. We have here hornblendic columns almost black, epidotic columns green, red feldspathic columns of granulyte and gneiss brilliantly red; other columns pink and gray. Stripes of orange and black lichens further diversify the coloration. Not to describe further, I venture the opinion that this spectacle is worthy of comparison with the "Pictured Rocks" of Lake Superior, and I propose to name it the Painted Castle of Minnesota.

In lithological composition it reproduces the features described in the foregoing notes.

Rock 279. Diallagic dioryte forming one of the beds in the Painted Castle.

HALT 695. N. W. ¼, N. E. ¼, S. 2, T. 65-11. Gneiss and schist as before.

HALT 696. N. W. ¼, N. W. ¼, S. 2, T. 65-11. Gneiss and schist as before.

HALT 697. N. E. ¼, S. W. ¼, S. 35, T. 66-11. Biotite gneiss with almost a complete absence of schists. Bedding traceable. Strike N. 51° E.

HALT 698. N. W. ¼, N. W. ¼, S. 35, T. 65-11. Gneiss with little mica. No schists and no conspicuous bedding lines.

HALT 699 N. W. ¼, S. W. ¼, S. 26, T. 66-11. Granite so far as shown, with a little biotite.

HALT 699 *bis*. N. W. ¼, S. E. ¼, S. 27, T. 66-11. In Canada. Biotite granite with little mica.

HALT 700. S. E. ¼, N. W. ¼, S. 27, T. 66-11. Gneiss. Has general aspect of granulyte, but bedding planes are here and there revealed. Strike N. 75° E. The quartz is smoky and tends to give the rock a granitic aspect at first glance, but the (biotite) mica is in small quantity.

HALT 701. S. W. ¼, S. E. ¼, S. 22, T. 66-11. Gneiss with clear quartz and a little more biotite than exists at the last three Halts. The rock is also coarser.

HALT 702. N. E. ¼, S. E. ¼, S. 22, T. 66-11. Biotite gneiss nearly granite for solidity, but still showing beds. Strike E. and W.

HALT 703. N. W. ¼, N. E. ¼, S. 22, T. 66-11. More schists than gneiss. Even the biotite gneiss is thin-bedded. Here are thick beds of biotite schist and ellipsoidal lumps of this and other rocks all stirred together, as it were, in a common stew. Strike N. 70° E.

HALT 704. S. W. ¼, S. E. ¼, S. 15, T. 66-11. Schists and gneiss in a maze of confusion. Strike N. 88° E. Dip N. 39°. The gneiss is biotitic and the commonest schist is biotitic. The gneiss is in beds half an inch thick and upwards to two feet; but every bed is rendered uneven or contorted by the inclusion of splinters and chunks of schist.

HALT 705. N. W. ¼, S. W. ¼, S. 15, T. 66-11. A great mixture of biotite gneiss and biotite schist remarkably twisted together. The general appearance of one spot is shown below:

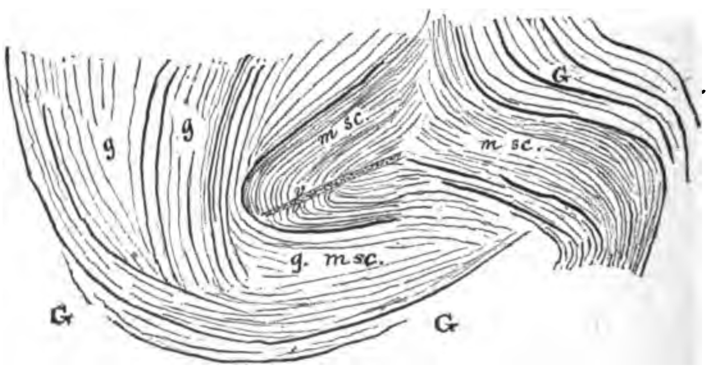

Fig. 42. Schist and gneiss intertwisted at Halt 705. on the boundary, near Crooked Lake.
m. sc. mica schist; g. gneissic; G. gneiss

HALT 706. S. W. ¼, N. E. ¼, S. 16, T. 66-11. Biotite gneiss and biotite schist interbedded as heretofore.

HALT 729. S. E. ¼, S. E. ¼, S. 16, T. 66-11. Gneiss and schist remarkably wound together. Strike unascertainable.

HALT 707. S. E. ¼, N. E. ¼, S. 17, T. 66-11. Ragged, schistic, warped in countless directions, gneiss itself schistic. Strike not certainly determinable, but in one place the beds are vertical, in other places dip in sundry directions.

HALT 708. Centre S. W. ¼, S. 17, T. 66-11. Biotite gneiss quite massive, but with interrupted bands of biotite schist with feldspar. Closely contiguous are found bands of biotite schist.

Memorandum.— Tower blasts are heard from here, a direct distance of 36 miles.

HALT 709. N. E. ¼, S. E. ¼, S. 18, T. 66-11. Biotite gneiss quite massive.

HALT 710. Near centre S. 18, T. 66-11. Biotite gneiss as above.

HALT 711. N. W. ¼, N. W. ¼, S. 18, T. 67-11. Biotite gneiss, interbedded with a dark syenite containing much diallage, some biotite and little quartz, also other beds of diallagic dioryte containing a pale green feldspar.

HALT 792. S. E. ¼, N. W. ¼, S. 13, T. 66-11. Biotite gneiss mostly coarse, and some schists; but half the formation is composed of a dark rock consisting of black lamellar hornblende and plagioclase, also some biotite.

Rock 280. Dioryte schist as above.

Rock 281. Dioryte schist from Halt 711.

HALT 713. N. W. ¼, N. W. ¼, S. 13, T. 66-12. Coarse granulyte and biotite gneiss.

HALT 714. N. W. ¼, S. 14, T. 66-12. Biotite gneiss interbedded with schist, either biotitic or diallagic, but much like Rock 280. Dip 30° N.

Rock 282. Biotite schist (diallagic?)

HALT 715. N. W. ¼, N. E. ¼, S. 15, T. 66-12. Island. Biotite gneiss very compact and with little biotite.

Rock 283. Biotite gneiss as above.

HALT 716. N. E. ¼, N. W. ¼, S. 15, T. 66-12. Island. Biotite gneiss poor in mica. Contains large angular pieces of an ambiguous rock which I think is dioryte schist.

HALT 717. N. W. ¼, S. E. ¼, S. 9, T. 66-12. Island. Biotite gneiss poor in mica, very compact, mostly coarse-grained. No bedding planes can be certainly determined. Glacial striæ south.

HALT 718. S. W. ¼, N. W. ¼, S. 9, T. 66-12. Biotite gneiss very compact, medium grain, poor in mica, like that at Halt 717, but a little finer.

HALT 719. N. E. ¼, N. E. ¼, S. 8, T. 66-12. Biotite gneiss, coarser than for some miles back, with red feldspar and a little more biotite. Exposed on the hills it gives them a bloody hue. The redness of the feldspar increases by weathering.

I find some beds with a deep red feldspar, very little quartz, crystals of a white or glassy feldspar, and an olive-greenish decaying mineral, which on the weathered surface, disappears, leaving cavities.

Rock 284. Decaying gneiss as above.

This bed strikes N. 60° E. with a dip of 85° S.

HALT 720. N. W. ¼, S. E. ¼, S. 5, T. 66-12. Island. Biotite gneiss, medium grain.

Rock 285. Biotite gneiss.

HALT 721. S. E. ¼, N. W. ¼, S. 5, T. 66-12. Biotite gneiss.

HALT 722. Canadian side, opposite N. W. ¼, N. E. ¼, S. 6, T. 66-12. Red biotite gneiss, coarse and poor in mica.

This locality is near the outlet of Crooked lake.

§ 15. IRON LAKE.

Iron lake is located on the national boundary west of Crooked lake. The American portion lies chiefly in T. 66-13, having a length of about three miles and an equal width. Only the eastern portion was explored, but as far as visited its shores are granite-bound and present the usual baldness and barrenness of granitic regions.

HALT 723. Falls into Iron lake, Canadian side. Red biotite gneiss. This formation is quite massive, scarcely any evidences of bedding being apparent; but lichens cover so much of the exposure that one can not be certain the traces of bedded structure are quite absent.

The falls are decidedly impressive. The volume of water is much greater than at Fall lake, but the descent I think about five feet less. I estimate it at 30 feet. Beyond is a further rapid descent of five feet, and moderate rapids continue for a quarter of a mile along the gorge. I judge the whole descent is not less than thirty-six feet. The scene ought to be photographed.

Rock 286. Red biotite gneiss, Halt 723.

HALT 724. American side of the falls. The formation shows a probable bedding with strike N. 62° E.

HALT 725. Canadian side near foot of rapids. Formation becomes schistose and includes beds of mica schist. On a second visit my attention was attracted by numerous fragments of a distinctly schistic character. Though not in place I am confident they are not far removed.

Rock 288. Biotite muscovite schist.

Rock 289. Gneiss distinctly bedded. From a fragment at Halt 725.

On the portage around the falls on the American side, I saw a fragment eight or ten feet in diameter showing similar bedding.

Rock 290. Coarse aggregation of quartz, feldspar and muscovite. This is from a fragment, but I saw plenty of it in place afterward.

Rock 291. Muscovite chlorite gneiss. From a fragment three or four feet long and three inches thick, therefore not far transported.

HALT 726. S. E. ¼, N. W. ¼, S. 6, T. 66-12. Biotite gneiss. Strong indications of bedding with strike N. 80° E.

HALT 727. S. W. ¼, S. W. ¼, S. 6, T. 66-12. Lofty ridge of gneiss, the bedding planes being obscure. To the southeast at the distance of an eighth of a mile lies another similar ridge. The dark mineral in this also is biotite but is not abundant.

I walked over this ridge and found only obscure evidences o bedding—still I think unequivocal. One of the specimens preserved (Rock 287) shows this.

Rock 287. Biotite gneiss.

HALT 728. N. W. ¼, S. W. ¼, S. 6, T. 66-12. Island lying mostly in T. 66-13. Biotite gneiss quite coarse, occasional crystals of orthoclase an inch on a side, mostly much less. Biotite is certainly present in small quantity and no hornblende.

The result of observations carried west to the border of range 13, and north over the bounds of Town 67, is to show that no rock answering the text-book definition of granite occurs. All the granitoid rocks are essentially bedded.

§ 16. CARP LAKE.

Carp lake is separated from Basswood by rapids flowing into Basswood. The portage is about a third of a mile long and lies on the east of the rapids. It is frequently known as Prairie portage. It is part of the highway between the east and west. Carp lake consists of two portions, one of which is rudely cir-

cular and lies on the boundary; the other is a broad, bent arm, extending first southeast into American territory three-fourths of a mile, and then southwest an equal distance. The northern portion lies in a basin bounded by a hard, diabase-looking, almost strictly massive, quartzo-feldspathico-aluminous schists which I have heretofore designated graywacke. The southern portion is excavated in the vertical edges of sericitic and chloritic schists, whose trend is here about 60° east of north. The axis of the southern arm of the lake is almost exactly northeast and southwest. It will be noticed that the two trends are not quite coincident, the axis of the lake making an angle of about 15° with the strike of the strata.

The name here employed is the one which I find on the government plats. The next lake to the east is named Sucker lake, and the next, lying mostly in Canada, is known in our notes as Pseudomesser lake. But some confusion seems to exist. On a map published in 1884 by the Department of the Interior of the Dominion of Canada, the lake here called Carp is nameless; the next east is called Birch lake, and the third is set down as Carp. If the first is properly known as Carp, it will be well to avoid a duplication, and for the same reason, the well-known name of Birch lake in Town 61-11 and 12 should take precedence of this Canadian lake in the application of the name.

HALT 453. S. W. ¼, S. W. ¼, S. 1, T. 64-9. Graywacke schist containing some chloritic material.

HALT 454. Entrance to Carp lake. Canadian side. Graywacke schist like the last.

HALT 455. S. W. ¼, S. W. ¼, S. 1, T. 64-9. Graywacke schist.

HALT 456. S. E. ¼, S. W. ¼, S. 1, T. 64-9. Graywacke schist with fine, shining points, as if the formation were becoming micaceous, or perhaps sericitic. Veins of quartz.

HALT 457. N. W. ¼, N. E. ¼, S 12, T. 64-9. Sericitic schist thinly laminated and shining, but with considerable silica and some quartz veins, but much more quartz in segregated lenticular laminæ. Strike N. 76° E. Dip about vertical.

HALT 458. N. W. ¼, N. E. ¼, S. 12, T. 64-9. Chloritic schist — bedding vertical.

HALT 459. N. W. ¼, N. E. ¼, S. 12, T. 64-9. Argillite, distinctly slaty, a little sericitic. Strike N. 60° E. Dip vertical.

Rock 191. Argillite. Two specimens from Halt 459.

HALT 460. S. W. ¼, N. E. ¼, S. 12, T. 64-9. Island. Sericitic schist, brown, not very smooth, soft. Strike N. 60° E. Dip vertical or N. 85°.

HALT 461. Near centre S. 12, T. 64-9. Argillitic sericitic schist — slaty to massive. Strike N 60° E. Dip vertical.

Rock 192. Argillitic sericitic schist.

HALT 462. At mouth of stream from Newfound lake. Sericitic argillite, slaty, vertical.

Rapids occur at the mouth of this stream; but no portage is required.

HALT 612. S. E. ¼, S. E. ¼, S. 1, T. 64-9. Argillite, blue and slaty. Strike N. 50° E. Dip S. 80.

HALT 613. N. E. ¼, S. W. ¼, S. 1, T. 64-9. Graywake schist with many coarsely granular quartz veins. Bedding scarcely determinable.

HALT 629. N. W. ¼, S. W. ¼, S. 1, T. 64-9. Hard, apparently altered, chloritic schist. Intersected by dikes and veins of a material fine and hard and appearing to consist of a dark hornblendic or augitic matrix in which are embedded lenticules of reddish petrosilex. Strike N. 44° E. Dip vertical.

Rock 251. Sample of above dikes.

Immediately contiguous to this on the north, is a chloritic schist which weathers green.

§ 17. NEWFOUND LAKE.

This is a narrow lake separated by a brief portage from the southern extremity of Carp lake. Its main axis lies northeast and southwest. It has a length of nearly three miles and a mean breadth of about a third of a mile. It occupies parts of sections 11, 12 and 14 of T. 64-9. Its shores present the usual diversity of forest, but with some abundance of sapling growths. The north-northwest shore supplies the greatest abundance of pines, and these are mostly Norways. The southeast side exposes very few rocky outcrops. The surface is generally covered by a light deposit of drift. The northwest side, however, presents a succession of vertical cliffs of sericitic and argillitic schists which have a general trend making an angle of about 15 degrees with the axis of the lake.

HALT 463. N. W. ¼, S. W. ¼, S. 12, T. 64-9. Sericitic argillite in high cliff four rods back from shore — slaty, vertical.

Rock 193. Sericitic argillite from Halt 463.

HALT 464. S. W. ¼, S. W. ¼, S. 12, T. 64-9. Sericitic argillite very slaty, vertical.

HALT 465. S. E. cor. S. 11, T. 64-9. Island. Sericitic argillite, smooth, drab, vertical.

HALT 466. N. W. ¼, N. E. ¼, S. 14, T. 64-9. Island. Argillitic sericitic schist.

Rock 194. Argillitic sericitic schist.

HALT 467. S. W. ¼, S. E. ¼, S. 11, T. 64-9. Island. Sericitic felsitic schist, weathering with a rough conglomeritic aspect, exposing many small feldspathic knobs and winding films of chloritic matter.

HALT 468. N. E. ¼, S. W. ¼, S 11, T. 64-9. Graywacke schist in a high rounded outcrop.

Rock 195. Graywacke schist as above.

HALT 469. N. E. ¼, N. E. ¼, S. 15, T. 64-9. Graywackenitic sericitic schist.

HALT 470. N. E. ¼, S. W. ¼, S. 15, T. 64-9. Chloritic sericitic schist, soft, with finely wavy fracture.

Rock 196. Chloritic sericitic schist.

HALT 471. N. E. ¼, S. W. ¼, S. 15, T. 64-9. Sericitic schists, soft, vertical. Strike N. 60° E.

HALT 472. N. E. ¼, N. W. ¼, S. 22, T. 64-9. At portage to Moose lake. Chloritic schist, compact, with diabasic aspect.

HALT 610. S. W. ¼, S. E. ¼, S. 12, T. 64.9. Newfound lake. Argillite. Dip vertical.

HALT 611. S. E. ¼, S. W. ¼, S. 12, T. 64-9. Argillite, greenish, thin, slaty. Dip vertical.

§ 18. MOOSE LAKE.

This is another elongated lake, lying almost in the axis of Newfound lake, but making a slightly larger angle with the meridian. Like that, its basin is a vertical chasm chiseled out of the edges of the upright sheets of sericitic and argillitic schists. These schists rise in wall-like barriers along the borders of the lake, and in several places present scenes of imposing grandeur and impressive interest. At several points they afford smooth and beautiful slates suitable for industrial use. The lake lies wholly in the south half of T. 64-9. From Snowbank lake it is separated by a range of hills which appear to be formed chiefly of a recurrence of graywacke lying between the sericitic schists and a southern range of syenite.

HALT 473. At end of portage from Newfound lake. Argillite, a little felsitic, alternating with a chloritic, somewhat graywackenitic schist. Strike N 42° E.

HALT 474. S. W. ¼, N. E. ¼, S. 22, T. 64-9. Chloritic schist, soft and slaty.

HALT 475. S. E. ¼, N. W. ¼, S. 22, T. 64-9. Little island. Here is a dike of apparently diabase, 30 feet wide, bounded on both sides by thin-bedded sericitic schists. The schists are rather soft, with quartzose intercalations. In contact with the dike the schist is hardened.

Rock 197. Diabase from dike.

Rock 198. Sericitic schist from actual contact with dike.

HALT 476. N. W. ¼, S. W. ¼, S. 22. T. 64-9. Compact, chloritic, sericitic schist, rising in a bluff seventy feet high, and extending along shore a quarter of a mile.

HALT 478, S. E. ¼, N. E. ¼, S. 21, T. 64-9. Chloritic, sericitic schist, mostly fine and massive, partly breaking with a fine, wavy fracture.

HALT 479. N. W. ¼, S. E. ¼, S. 21, T. 64-9 Sericitic schist, slaty, bluish-gray, weathering buffish. A grand, enormous exhibition in a cliff fifty feet high and a third of a mile long. Would probably be suitable for roofing. Can be split into laminæ one-sixteenth of an inch thick.

Rock 199. Sericitic slate as above.

I saw great tables weathered out ten feet square — instead of disintegrating into chips, like the similar schist about Long and Fall lakes.

HALT 480. N. W. ¼, S. W. ¼, S. 28, T. 64-9. Sericitic schist, slaty, dipping S. 85°.

HALT 481. S. E. ¼, S. E. ¼, S. 29, T. 64-9. Chloritic argillite.

HALT 482. S. W. ¼, N. W. ¼, S. 31, T. 64-9. An enormous cliff of erupted material sixty or seventy feet high. At the base, near the water, some of it at least, is gabbro-like. Part way up and thence to the top, it appears like a diabase, but may be only a finer norite (gabbro). This probably is a great dike.

Rock 200. Diabase from cliff at Halt 482.

HALT 483. N. W. ¼, N. E. ¼, S. 31, T. 64-9. Buff sericitic slate, standing vertical.

HALT 484. S. E. ¼, S. 30, T. 64-9. Sericitic schist, thin, slaty. Strike N. 62° E. Dip vertical.

HALT 485. N. W. ¼, S. W. ¼, S. 29, T. 64-9. Argillite, beau-

tifully slaty, with smooth surfaces. Parts of it do not split easily. Strike N. 70° E. Dip N. 85°.

Rock 201. Argillite.

HALT 486. N. W. ¼, S. W. ¼, S. 29, T. 64-9. Sericitic schist, warped irregularly, rather hard, brownish.

HALT 487. N. E. ¼, S. W. ¼, S. 29, T. 64, 9. Chloritic, sericitic schist, greenish, with dark-green surfaces on the fracture, soft, slaty, but with occasional silicious laminæ. Dip vertical. Large exposure.

Rock 202. Chloritic, sericitic schist.

I was greatly perplexed to find a portage from this lake to Snowbank. This is partly due to the fact that only a faint trail exists, but more largely to the execrable condition of the government plats and the government survey. I found the large island on the east side, on the line between secs. 28 and 29, joined to the main land. I found many other errors in the plat. But more vexatious still, is the total absence of meander stakes, or if present occasionally, a perfectly illegible scrawl for a record.

§ 19. SNOWBANK LAKE.

Snowbank lake is about five miles long, and the main body of it is two and a quarter broad. The southern half of its outline is deeply indented by many irregular capes and peninsulas, and the surface of that part is much broken by islands, one of which is a mile in length. The lake lies in towns 64-8 and 9 and 63-9.

Snowbank lake has apparently been little frequented. Trails to and from it are very obscure and difficult. Much of the lake is shallow, and dangerous shoals and reefs are frequent. Many rock fragments, also, rise abruptly to and near the surface, in places where the water is generally deep. The dangers of canoeing are apt to be much increased by the prevalence of high winds, which sweep over the broad expanse of surface.

One can not enter this hydrographic basin without feeling impressed by its peculiar physical aspects. Compared with Burntside and Vermilion lakes, it has a distinctly more northern expression. Here is a marked diminution of pines, and a corresponding increase of white cedars and spruces. As along the northern shores of Lake Huron, the cedars fringe the lake and overhang the water in a somewhat continuous barrier. The long, beard-like lichen, *Usnea barbata*, hangs from the stunted

branches of the firs, and a growth of ancient mosses covers the surface of the earth with a deep and scarcely interrupted cushion. Here is a primeval condition of the wilderness. No fires have swept over the country. The geologist is compelled to camp nightly in the midst of the forest, and make his bed on a growth of damp mosses. The mossy bed is often a foot or two deep, but it is damp, and the underlying sharp fragments of syenite project upwards with very uncomfortable inequalities.

There are other contrasts with the lakes further west. The crows have disappeared, and the white-throated sparrow, so-called, is no longer heard, nor the feeble-voiced robin. But great gulls soar in considerable numbers overhead, and the great northern loon screams with voice startlingly loud and shrill. Fishes appear to be scarce, for we did not succeed in taking a single specimen with the hook.

The lake is bound in a massive rim of crystalline rocks. These are prevalently syenitic, but near the eastern extremity they become graywackenitic, hard, badly bedded, and decidedly diabasic in external aspect. Part of the northwestern shore was not visited; but it may safely be set down as syenitic.

HALT 488. N. E. ¼, S. W. ¼, S. 28, T. 64-9. On the Portage from Moose to Flask lake. Abundant fragments indicate the presence of a dike of norite in this ridge.

HALT 489. N. W. ¼, S. E. ¼, S. 28, T. 64-9. Chloritic diabasic schist, compact, greenish, with a base somewhat felsitic, and containing undefined grains of lighter feldspar.

HALT 490. N. E. ¼, N. E. ¼, S. 33, T. 64-9. Flask lake. Compact, graywackenitic sericitic schist, weathering rugged and knotted, as often seen before.

HALT 491. N. E. ¼, N. E. ¼, S. 33, T. 64-9. Flask lake. Porphyritic diabase of dark gray color, rather aphanitic, but with black, disseminated crystals of a mineral resembling augite, and of a light pinkish feldspar.

Rock 203. Porphyritic diabase.

HALT 492. N. W. ¼, N. W. ¼, S. 34, T. 64-9. Porphyritic diabase—same as Halt 491.

HALT 493. S. W. ¼, S. W. ¼, S. 27, T. 64-9. Diabase with same black crystals, but no feldspar crystals.

The portage to Snowbank lake is difficult to find. It is half a mile from the nearest point to Snowbank lake.

HALT 494. S. W. ¼, S. W. ¼, S. 27, T. 64-9. Diabase?—resembling the groundmass of that occurring at Halts 491 and 492,

but with no disseminated crystals either of augite or feldspar. Supposing this continuous with the rock at Halt 491, we have a mass half a mile wide. I presume it is continuous, for there is no schist seen along the southeast shore, and the diabase outcrops almost uninterruptedly. If such a dike of diabase rose here, there must have been a yawning chasm—one might perhaps say, an improbable chasm. But the distance indicated may mark the longitudinal extent. If so, it stands in general conformity with the strike of the schists.

Rock 203. Diabase from Halt 494. I find this rock extremely hard.

HALT 495. S. E. ¼, S. W. ¼, S. 27, T. 64-9. On portage from Flask to Snowbank lake. Diabase, very hard—same apparently, as at Halt 494.

HALT 496. N. W. ¼, N. E. ¼, S. 34, T. 64-9. End of portage. Diabase? a large boss, character quite like that at Halt 494, at the other end.

HALT 497. N. W. ¼, N. E. ¼, S. 34, T. 64-9. Diabase?

HALT 498. S. W. ¼, N. E. ¼, S. 34, T. 64-9. Porphyritic diabase as at Halt 491.

HALT 499. N. W. ¼, S. W. ¼, S. 35, T. 64-9. Syenite, fine-grained, with pale pinkish feldspar and little quartz.

Rock 204. Syenite from Halt 499.

HALT 500. S. E. ¼, N. W. ¼, S. 35, T. 64-9. Syenite with red feldspar and compact texture.

Rock 205. Syenite, Halt 500.

HALT 501. N. E. ¼, S. E. ¼, S. 35, T. 64-9. Reef. Red syenite, rather coarse.

HALT 502. S. E. ¼, N. E. ¼, S. 35, T. 64-9. Syenite.

HALT 503. S. W. ¼, N. W. ¼, S. 36, T. 64-9. Syenite, medium texture, white feldspar, and large, conspicuous and well-defined grains of black hornblende.

HALT 504. N. E. ¼, S. W. ¼, S. 36, T. 64-9. Syenite like last.

HALT 505. S. W. ¼, N. W. ¼, S 1, T. 63-9. Syenite, finer than at Halt 504, with a little larger proportion of hornblende.

HALT 506. S. E. ¼, N. W. ¼, S. 1, T. 63-9. Island. A mass of syenite.

HALT 507. S. E. ¼, S. W. ¼, S. 1, T. 63-9. Syenitic fragments cover the beach. No outcrop.

Made faithful examination of the creek emptying in here, with the view of reaching the large lakes from which it flows.

But the creek was impassable, and no portage could be found though we searched carefully both sides. From our failure I gave the name "Disappointment" to the larger.

HALT 508. N. W. ¼, N. E. ¼, S. 12, T. 63-9. On the creek, north side. Graywacke, but not much exposed.

HALT 509. N. E. ¼, S. W. ¼, S. 1, T. 63-9. Syenite but unusually fine, constituents in equal proportions.

HALT 510. Centre S. 1, T. 63-9. Syenite with red feldspar.

HALT 511. S. W. ¼, S. W. ¼, S. 31, T. 64-8. Syenite.

HALT 512. S. W. ¼, S. E. ¼, S. 31, T. 64-8. Syenite with red feldspar.

HALT 513. N. E. ¼, S. E. ¼, S. 31, T. 64-8. Syenite rather coarse. The dark mineral is greenish and rather dull; but small portions of it are a clear, glassy, yellowish green.

Rock 206. Syenite with greenish hornblende.

This syenite presents a horizontally-bedded structure, like that seen in Basswood lake, but the beds are much thicker. (Halt 440 *et seq*).

HALT 514. S. E. ¼, S. E. ¼, S. 31, T. 64-8. Syenite with red feldspar.

HALT 515. S. E. ¼, N. E. ¼, S. 31, T. 64-8. Syenite.

HALT 516. S. E. ¼, N. E. ¼, S. 31, T. 64-8. Syenite horizontally bedded.

HALT 517. N. E. ¼, N. E. ¼, S. 31, T. 64-8. Syenite like that at Halt 513.

HALT 518. S. E. cor. S. 30, T. 64-8. Syenite, fine, with glistening crystal faces of glassy feldspar.

HALT 519. S. E. ¼, S. E. ¼, S. 31, T. 64-8. Island. Fundamentally fine syenitic gneiss; but in places it is interbedded with fine hornblende schist. A dike of diabase 18 inches wide intersects the mass transversely. The bedding here is inconspicuous. We seem to have syenite in progress of passage to hornblende schist. In streaks I find also some muscovite.

Rock 207. Fine compact gneiss.

Rock 208. Fine compact gneiss. (I surmise one of these is diabase like.)

Rock 209. Interbedded gneiss and hornblende schist.

HALT 520. N. W. ¼, N. W. ¼, S. 29, T. 64-8. Syenite like that of Halts 513, 517.

HALT 521. N. W. ¼, S. W. ¼, S. 29, T. 64 S. Fine syenite gneiss interbedded with fine, compact, graywacke hornblende

schist. Similar outcrops were seen along the shore, but the water was too rough to land.

HALT 522. N. W. ¼, S. W. ¼, S. 29, T. 64-8. Very finely granular graywacke schist. There are shining particles, but they do not appear to be mica or hornblende. Still, some scales of muscovite are recognizable, and I have a suspicion that the rock is incipient mica schist.

Rock 210. Graywackenitic mica schist.

The rock is unmistakably bedded, and is interstratified with syenitic gneiss, muscovite gneiss and muscovite schist, with some feldspar. Some of the muscovite gneiss is quite coarse.

HALT 523. S. E. ¼, N. W. ¼, S. 29, T. 64-8. Fundamentally as at Halt 522. Some mica is disseminated, and some beds are typical mica schist. Obscure veins intersect the formation, and stand salient on weathered surfaces. This is again the so-called "sewed-up rock." Strike appears to be N. 28° E.

Rock 211. Graywackenitic mica schist with distinct mica on one side.

Rock 212. Mica schist from close proximity with Rock 211.

HALT 524. Near centre of S. 29, T. 64-8. Syenite with red feldspar.

HALT 525. N. E. ¼, S. W. ¼, S. 29, T. 64-8. Syenite, fine, with deep red feldspar.

Rock 213. Syenite as above.

HALT 526. S. E. ¼, N. W. ¼, S. 29, T. 64-8. Syenite — two sorts — one, medium texture with excess of hornblende disposed in rude layers and forming a gneiss; the other, very coarse, having crystals of bluish feldspar three-fourths of an inch long.

Rock 214. Gneiss.

Rock 215. Very coarse syenite.

HALT 527. S. E. ¼, N. W. ¼, S. 29, T. 64-8. A distinctly schistose rock, very compact, of that nondescript kind which I have denominated graywackenitic mica schist—same as Halt 522.

HALT 528. N. E. ¼, N. E. ¼, S. 29, T. 64-8. Schist very distinct — weathering a little greenish, but of a nondescript character, like the rock at Halt 527. There is, in addition, a diffusion of a little chloritic matter. The wrinkled and rough condition of the weathered surface also implies this. It contains beds of syenitic gneiss. Strike N. 11° E. Dip N. 80°.

In parts, the chloritic matter is conspicuous.

Rock 216. Graywackenitic, chloritic schist, Halt 528.

HALT 529. S. W. ¼, S. E. ¼, S. 20, T. 64-8. Appears like the graywackenitic mica schist in an exceedingly fine state. It is dark gray and has the aspect of argillite not fully developed. Strike seems to be N. 20° W. Dip N. 75°.

There is some mica schist.

Rock 217. Mica schist very fine, from Halt 529.

HALT 530. N. E. ¼, S. W. ¼, S. 20, T. 64-8. Chloritic sericitic schist. Strike N. 31° W. Dip N. 80°.

HALT 531. N. E. ¼, S. W. ¼, S. 20, T. 64-8. Fine, compact, chloritic, felsitic schist, varying from bed to bed — distinctly stratified but very solid.

Nearer the water the surface is perforated by thousands of little circular holes one-sixteenth of an inch in diameter and very uniform. They are mostly arranged in linear series conformable with lines of structure in the rock, but running in all directions in the different regions. Sometimes they appear somewhat as follows:

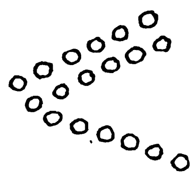

Fig. 43. Arrangement of holes in the rock surface at Halt 531. Snowbank Lake.

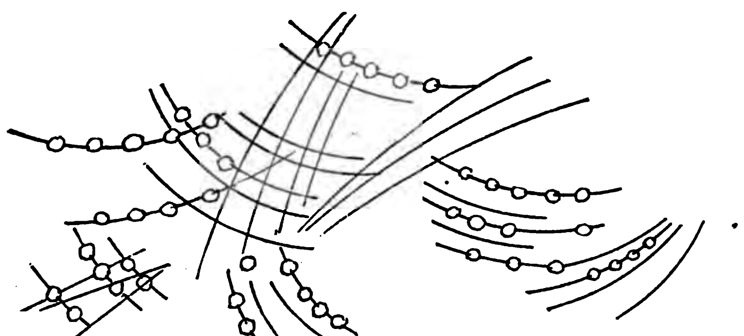

Fig. 44. Another arrangement of holes at Halt 531. Not thought to have any geological significance.

The series of pits are situated in curved grooves. The lines without pits are salient and vein-like. They separate the series of pits, and also intersect the general field.

Strike N. 38° W. Dip vertical.

Adjoining this on the north, the schist is graywackenitic mica schist.

HALT 532. S. W. ¼, N. W. ¼, S. 20, T. 64-8. Graywackenitic mica and hornblende schist. Some parts reached by atmospheric action are distinctly hornblende schist with much feldspar.

The narrow deep bay indicated on the plat is not here.

HALT 533. N. W. ¼, S. 20, T. 64-8. Fine dark-grayish very compact, graywackenitic-looking rock, some of which weathers brick-red, and some is greenish with epidote. It forms an escarpment 40 feet high. Divisional planes give some of it the appearance of horizontal stratification. It includes masses of black hornblende rock; and in places, hornblende schist is interbedded with the true bedding, which is nearly vertical. It contains, also, irregular masses of syenite.

HALT 534. S. E. ¼, N. E. ¼, S. 19, T. 64-8. A puzzling mixture again, containing graywacke schist, hornblende schist, syenite, felsitic schist, dioryte schist, etc.

Rock 217 *bis*.	Graywacke schist.	All mixed and interbedded.
Rock 218.	Dioryte schist.	
Rock 219.	Gneiss.	

HALT 535. S. E. ¼, N. E. ¼, S. 19, T. 64-8. Syenite—typical and unmixed.

This is an important observation, since it brings the crystallines far across the strike of the schists, and intimates that there may be, east of Snowbank lake, a connection between the White Iron syenites and the Basswood lake syenite. In accordance with this, the strike of the schists has recently been northerly and even northwesterly. This conjecture renders it all the more regretable that I could not get into Disappointment lake southeast of Snowbank.

HALT 536. N. W. ¼, S. W. ¼, S. 19, T. 64-8. Town line. Syenite.

Before dismissing Snowbank lake, it is due the government surveyors to testify that their work on the shores of the lake is even more execrable and misleading than that on Moose lake. There are several indications that some parts of the plat were laid down from memory. Thus particular features, besides being inexact, are quite erroneously located. Meander stakes, when present, are marked in the same illegible style as on Moose lake. These faults are more egregious in T. 64-8 than in T. 64-9.

§ 20. BOOT LAKE AND VICINITY.

Boot lake is a small body of water lying in an unbroken and almost unvisited wilderness in S. 21, T. 64-8. As it forms part of the long and difficult and badly platted route between Snowbank and Ensign lakes, it seems best to assign it to a special section. Its physical characteristics are identical with those of Snowbank lake. The geographical features of the region will be noticed in connection with the geology. On the east side of Snowbank lake is a deep narrow bay not laid down on the plat, and here a small stream conveys the drainage of the lake down a series of rapids into a small lake which I have named Shot lake. Other rapids connect this with Boot lake. A stream from Boot lake flows northeast into a stream from Jordan lake which I call Jordan creek; and this continues its course nearly north through a long estuary into Ensign lake.

HALT 537. S. W. ¼, N. W. ¼, S. 20, T. 64-8. On portage from Snowbank to Shot lake. Mongrel rock. Constituents of syenite and hornblende schist intermingled.

Rock 220. Syenitic, hornblendic schist.

HALT 538. End of portage, on Shot lake. Mongrel rock as before, with masses of syenite included; also veins of syenite.

HALT 539. N. W. ¼, S. W. ¼, S. 21, T. 64-8. Northeast side of Shot lake. Mongrel rock continues.

HALT 540. N. W. ¼, S. W. ¼, S. 21, T. 64-8. End of portage from Shot to Boot lake. "Sewed-up rock," a fine graywackenitic mica schist, intersected by obscure veins in many directions.

HALT 541. S. side N. E. ¼, S. 21, T. 64-9. On Boot lake. Graywackenitic or compact, chloritic schist, hard and greenish, apparently felsitic.

HALT 542. N. E. ¼, N. E. ¼, S. 21. T. 64-8. On boot lake. Greenish felsitic schist, very variable in texture. Strike N. 78° W. On weathered surfaces feldspar spots appear. Some parts contain large, light-colored felsitic patches.

Rock 221. Felsitic schist.

HALT 543. S. W. ¼, S. E. ¼, S. 16, T. 64-8. Northern extremity of Boot lake, on little bay not shown on plat. Sericitic schist, soft, light-drab, thinly laminated. Strike N. 80° W. Dip vertical.

Rock 222. Sericitic schist, from Halt 543.

The stream platted as entering at the southeast corner of Boot

lake does not exist. On the contrary, the little bay putting out at the northeastern angle is not platted; nor is the stream which finds exit here. This is not canoeable, but a very obscure trail leads along the east side of it.

HALT 544. S. W. ¼, S. E. ¼, S. 16, T. 64-8. One fourth mile on portage beyond Boot lake. Course N. 7° E. Sericitic schist, bluish, easily split. Strike N. 76° W. Dip 90°.

HALT 545. S. W. ¼, S. E. ¼. S. 16, T. 64-8 One-eighth mile on portage. Sericitic schist, bluish, warped, efflorescing, thin-laminated. Strike E. and W. Dip 90°.

A high cliff of this schist extends along the east side of the portage. It continues along the creek a distance of a quarter of a mile in a direction varying from N. 12° E. to N. 32° E. The strike of the vertical beds becomes N. 84° E. The cliff then trends more southeasterly.

In half a mile or less, the creek is met by Jordan creek, which is somewhat larger, and flows N. 53° W.

HALT 546. About N. W. ¼, S. W. ¼, S. 15, T. 64-8. On Jordan creek, one-fourth mile above junction with Boot Lake creek. Rapids all the way, and here is quite a pretty cascade over buffish, soft, sericitic slates standing vertical and having a strike N. 88° W. The cliffs rise on either hand 20 to 30 feet. On the top of the cliff stands a primeval forest, dense with undergrowth. But some thrifty pines—white and Norway, are seen, intermixed with spruce and cedars. One white pine measured 3 feet in diameter.

Above the falls, rapids continue at least a quarter of a mile. There is no trail, and therefore no indication of considerable water further up. I had to abandon the project, therefore, of getting into Jordan lake by this stream.

HALT 547. N. W. ¼, S. W ¼, S. 15, T. 64-8. Near beginning of portage beyond the stream. Greenish sericitic schist. Strike N. 88° W. Dip 60° S. This dip is in the creek; near by, in the bluff, the dip is vertical. Direction of the trail and creek N. 22° E.

The above Halt is at the northeast end of a pool one-tenth of a mile long, over which we floated the canoe. We then found rapids and took a poor trail on the west of the stream around them. This portage is about one-fifth of a mile.

HALT 548. About S. W. ¼, N. E. ¼, S. 15, T. 64-8. Sericitic schist, drab and soft and shaly.

This creek is broad, but shallow, and often obstructed by rocks

and fallen timber. Many places where the canoe must be hauled by men wading in the water, but there is no trail along the banks. Then another open place follows — one-tenth of a mile — then obstructions again. The plat is absolutely worthless. The stream finally widens out into an estuary setting northwest, instead of a delta setting northeast, and the mouth appears to be a third of a mile west of the place indicated.

§ 21. ENSIGN LAKE.

The best approach to Ensign or Mountain lake, and the only one which appears to be used, is at the west end, where a broad and canoeable stream (not so represented on the plat) flows out into Cap lake. From the northwestern angle of this, a high and dry portage, one-fourth of a mile long, connects with Carp lake. The stream which drains Cap lake into Carp is not canoeable; it is a continuous rapid, and no trail exists along its border, though we forced our way through. Ensign lake is long, narrow and irregular. It lies in the northern half of T. 64-8, and its main axes trend east and west. Its physiographic aspect is less severe and boreal than that of Snowbank; but the lake-fringe of white cedar and spruce is still a marked feature, and its waters are poor in fish. The lake lies upon the eroded vertical edges of a mass of schists whose strike has determined its main axes. It has about 14 miles of shore-line, and studies have been made at 55 Halts.

The faulty platting of the lake is partially corrected on the map accompanying this report. The geological description begins at the point of approach from Snowbank lake.

HALT 549. N. E. ¼, N. W. ¼, S. 15, T. 64-8. Ensign lake. Sericitic schist, yellowish-blue, partly quite shaly, partly more solid. Occasional fragments of a black, compact argillite appear, but they are not in the near neighborhood of an outcrop.

The formation varies from sericitic schist as above, to rough, compact argillite, and thin-laminated argillite.

Rock 223. Sericitic schist.

Rock 224. Compact, argillitic schist.

Rock 225. Thin-laminated argillite.

Strike N. 89° E. Dip vertical.

HALT 550. N. W. ¼, N. W. ¼, S. 15, T. 64-8. Island. Argillitic sericitic schist — even and slaty. Strike E. and W. Dip N. 85°. At the western end of the island the rock is more massive.

HALT 551. N. W. ¼, N. W. ¼, S. 15, T. 64-8. Argillitic sericitic schist.

HALT 552. N. E. ¼, N. E. ¼, S. 16, T. 64.8. Argillitic sericitic schist. Dip N. 75°, but possibly disturbed.

HALT 553. N. E. ¼, N. W. ¼, S. 16, T. 64-8. Bluish, argillitic sericitic slate. Strike N. 75° E. Dip 80°.

Rock 226. Argillitic sericitic schist.

HALT 554. N. E. ¼, N. E. ¼, S. 17, T. 64-8. Argillitic sericitic schist, bluish, not smooth, with minute glistening specks and a few black ones. Indications of a waxy pervasive matrix. Dip N. 75°.

Rock 227. Argillitic sericitic schist.

HALT 555. N. W. ¼, N. E. ¼, S. 17, T. 64-8. Chloritic, sericitic schist, weathering black and ragged, with many holes, circular, oblong and elongate, in the exposed edges of the beds. Immediately contiguous, the rock is highly sericitic, early crumbling to chips. Strike N. 74° E. Dip 86° S.

Rock 228. Sericitic schist.

HALT 556. S. E. ¼, S. W. ¼, S. 8. T. 64-8. Island. Felsitic schist varying to sericitic felsitic schist—compact, some portions hard and massive, others easily cleavable.

Rock 229. Felsitic schist (poroditic?).

Rock 230. Sericitic, felsitic schist.

The felsitic portion is in places porphyritic with undefined grains of feldspar. Strike N. 70° E. Dip vertical.

HALT 557. S. W. ¼, S. W. ¼, S. 8, T. 64-8. Island. Chloritic sericitic schist—bluish, soft, weathering vacuous, thin-laminated, but laminæ not really separating, many thin lenticules of felsitic matter interlaminated. Strike N. 74° E. Dip vertical.

HALT 558. S. E. ¼, S. E. ¼, S. 7, T. 64-8. Island. Argillitic sericitic schist. Dip vertical.

HALT 581. S. W. ¼, S. E. ¼, S. 7, T. 64-8. Sericitic argillite. Strike N. 64° E. Dip 76° N.

Rock 239. Sericitic argillite.

HALT 580. S. W. ¼, S. E. ¼, S. 7, T. 64-8. Near outlet of lake. Chloritic sericitic schist, same as at Halt 567—the chloritic matter bright green, and the formation having veins of quartz.

The stream flowing out of Ensign lake I call Ensign river. Its entrance is obstructed, but beyond it is broad and deep. It carries the waters of Ensign, Shot, Snowbank, Nameless and

Disappointment lakes, as well as those of Jordan, Ima, Thomas and Fraser lakes.

In this connection I notice the geology of Ensign river and of Cap lake into which it flows.

HALT 605. S. E. ¼, S. W. ¼, S. 7, T. 64-8. On Ensign river or estuary. Chloritic, sericitic argillite. Strike N. 52° E. Dip N. 75°.

HALT 606. S. W. ¼, S. W. ¼, S. 7, T. 64-8. Cap lake. Sericitic argillite. Strike N. 62° E. Dip vertical.

HALT 607. N. W. ¼, S. W. ¼, S. 7, T. 64.8. Argillite slightly sericitic. Strike N. 52° degrees E. Dip N. 75°.

HALT 608. S. W. ¼, N. W. ¼, S. 7, T. 64-8. Sericitic schist. Strike N. 38° E. Dip vertical.

HALT 609. S. E. ¼, S. E. ¼, S. 12, T. 64-9. Near outlet of Cap lake. Compact, hard argillite. Strike N. 52° E. Dip vertical.

HALT 579. S. W. ¼, S. E. ¼. S. 7, T. 64-8. Argillite. Dip 80° E.

HALT 578. N. E. ¼, S. E. ¼, S. 7, T. 64-8. Chloritic argillite with knots of apparently feldspathic matter, giving an uneven surface. Strike N. 62° E. Dip vertical.

HALT 577. N. W. ¼, S. W. ¼, S. 8, T. 64-8. Felsitic, sericitic schist, with disseminated grains of quartz. Composed of many alternating qualities. Flatened lenticular and globoid masses of syenite, and various qualities of the country rock are embraced in the bedding, and the beds are warped around them and fitted to them. General character like that at the point opposite—Halt 561. Strike N. 60° E.

HALT 559. N. E. ¼, S. E. ¼, S. 7, T. 64-8. Point. Argillitic sericitic schist.

HALT 560. N. W. ¼, S. W. ¼, S. 8, T. 64-8. Chloritic, sericitic schist.

HALT 582. S. W. ¼, S. E. ¼, S. 8, T. 64-8. Argillite, slaty, some of it smooth and fine, some rough, lenticules of quartz. Strike N. 64° E. Dip N. 75°.

Rock 240. Argillite.

HALT 583. N. W. ¼, S. E. ¼, S. 8, T. 64-8. Chloritic argillite, with grains of quartz and feldspar scattered through it. Strike N. 48° E. Dip N. 86°.

HALT 561. S. E. ¼, N. W. ¼, S. 8, T. 64-8. Point. Chloritic sericitic schist, varying to compact, hard, greenish felsitic schist, with darker green grains. Interbedded are many rounded

lumps of syenite, many lenticular masses, and many real beds—as also beds and lenticules of petrosilex, quartz and granulite. Strike N. 62° E. Dip vertical.

HALT 562. S. W. ¼, N. E. ¼, S. 3, T. 64-8. Argillitic sericitic schist in a cliff 15 feet high. Dip vertical.

HALT 563. S. E. ¼, N. E. ¼, S. 8, T. 64-8. Light sericitic schist similar to that at Halt 555, but more easily goes to fine chips.

HALT 564. S. W. ¼, N. W. ¼, S. 9, T. 64-8. Chloritic and graywakenitic schists in alternation—also some syenitic lenticules and rounded lumps. It is noticeable that the laminæ are warped around the lumps as if the latter had been introduced as pebbles. The lenticules appear like segregations.

HALT 565. S. E. ¼, N. W. ¼, S. 9, T. 64-8. Chloritic sericitic schist. A dike-like bed of diabasic material 12 inches wide, stands perfectly conformable with the schist, and the contiguous schist is little, if any, altered. The schist contains lumps and interbeddings of dioryte. All these sorts of rocks also graduate into each other. The formation appears to have been a mixture of constituents, which at one point arrange themselves in one aggregation of minerals, and, at another point, in another aggregation.

Rock 231. Chloritic, sericitic schist with a felsitic band.

Rock 232. Schist in absolute contact with the dike. (The weathered side.)

Rock 233. Diorite in the above schist.

Rock 234. Syenite in the above schist.

HALT 566. S. E. ¼, N. W. ¼, S. 9, T. 65-8. Chloritic, sericitic schist. The chloritic constituent is bright green and gives the rock a showy appearance. Would be a handsome rock for polishing. It weathers rusty.

Rock 235. Chloritic sericitic schist—several specimens.

HALT 567. A few rods further east, this formation is intersected by massive veins of white, opaque quartz, which appears to cut the bedding transversely. These veins branch extensively, and in their ramifications become intimately mixed with the schist, giving it a granular, and finally, a simply silicicous constitution. Some portions of the schist here are massive and hard, with a russet color; but I find the schist in actual contact with the quartz not at all hardened or otherwise altered.

Rock 236. Relation of quartz and schist.

HALT 568. S. W. ¼, N. E. ¼, S. 9, T. 64-8. Argillite finely silicious but slaty. Strike N. 82° E. Dip 85° S.

HALT 569. N. W. ¼, N. E. ¼, S. 9, T 64-8. Chloritic sericitic schist with quartz grains disseminated through it, also some feldspar grains; intersected also by quartz veins of dike-form crossing the bedding diagonally. Rock contains also fragments of sericitic schist.

Rock 237. Chloritic sericitic schist with quartz grains.

HALT 570. N. E. ¼, N. W. ¼, S. 9, T. 64-8. Chloritic graywackenitic schist in a high cliff. Dip. S. 75.

HALT 571. S. W. ¼, N. W. ¼, S. 9, T. 64-8. Argillite, slate color, rather slaty structure, weathering greenish. Strike N. 67° E. Dip. S. 85°.

HALT 572. N. E. ¼, N. W. ¼, S. 8, T. 64-8. Solid schistose rock, consisting of interbedded argillite and felsitic schist. Strike N. 42° E.

HALT 573. N. W. ¼, N. E. ¼, S. 8, T. 64-8. Argillite, compact, non-slaty, mostly with disseminated grains of quartz and some feldspar.

Rock 238. Argillite and quartz.

HALT 574. N. E. ¼, N. W. ¼, S. 8, T. 64-8. Argillite distinctly bedded, but non-slaty. Strike N. 28° E. The strike varies five or ten degrees in the distance of 20 feet. Formation weathers in a very rugged and peculiar way.

HALT 575. Centre N. W. ¼, S. 8, T. 64-8. Sericitic argillite. Strike N. 41° E. Dip. S. 82°.

HALT 576. N. E. ¼, N. E. ¼, S. 7, T. 64-8. Argillite, gray-greenish, compact, with apparently a felsitic matrix, but very distinctly bedded. Strike N. 50° E. Dip vertical.

HALT 584. S. E. ¼, S. W. ¼, S. 9, T. 64-8. Sericitic argillite, thinly laminated and very slaty, the laminæ mostly waxy. There are many interlaminated sheets of quartz, and these occasionally branch across the laminæ of schist. Some of the laminæ are sharply plicated, and the included laminæ of quartz are quite conformable. But in such case, the quartz tends also to dissemination through the schist.

In one case I counted seven laminæ of quartz in the space of 4½ inches, and in another 7, less continuous, in the space of two inches. In the first case, the laminæ can be traced continuously six feet, and then they disappear in both directions under the earth.

Rock 241. Sericitic schist and one of 7 laminæ of quartz in 7 inches.

Rock 242. Plicated schist with quartz laminæ.

HALT 585. S. W. ¼, S. E. ¼, S. 9, T. 64-8. Sericitic argillite.

HALT 586. S. W. ¼, S. W. ¼, S. 10, T. 64-8. Sericitic schist, very soft and thinly laminated. Strike N. 63° E. Dip 78° S.

HALT 587. N. W. ¼. S. E. ¼, S. 10, T. 64-8. Pale-buff sericitic schist, but packed full of grains of quartz and feldspar. On the weathered surfaces these grains stand prominent and whitish, giving the rock a granitic appearance. Some quartz veins run through it, and the bedding is warped and quite irregular. Strike N. 52° E. Dip?

Rock 243. Sericitic schist with quartz and feldspar grains.

HALT 588. N. W. ¼, S. E. ¼, S. 10, T. 64-8. Argillite. Strike N. 82° E. Dip S 75°. Glacial striæ S. 13° W.

HALT 589. Centre of S. 10, T. 64-8. Argillite packed with grains of quartz. Rock compact, hard, little slaty. Strike N. 82° E. Dip S. 76°.

Rock 244. Argillite with quartz grains.

HALT 590. S. E. ¼, N. W. ¼, S. 10, T. 64-8. Argillite smooth and slaty. Strike N. 73° E. Dip S. 80°.

HALT 591. N. W. ¼, N. W. ¼, S. 10. T. 64-8. Gravelly sericitic schist. It is packed with grains of quartz and feldspar. Strike N. 72° E. Dip vertical. Glacial striæ S. 12° W. and S. 32° W.

HALT 592. N. W. ¼, N. W. ¼, S. 10, T. 64-8. Felsitic argillite. Argillite reduced to the last degree of compactness and hardness by increase of silica and feldspar. Some is a fine homogeneous felsite of greenish-drab color, containing fragments of dark-gray argillite, shown in one of the specimens 245. Strike N. 70° E.

Rock 245. Felsitic argillite and argillitic felsite.

HALT 593. S. W. ¼, S. W. ¼, S. 3, T. 64-8. Felsitic argillite not so hard as the last.

HALT 594. N. E. ¼, N. W. ¼, S. 10, T. 84-8. Felsitic, sericitic schist somewhat silicious, weathering rather rough.

HALT 595. S. E. ¼, N. E. ¼, S. 10, T. 64-8. Sericitic argillite, rough and weathering harsh. Strike N. 78° E. Dip 60° S.

HALT 596. S. E. ¼, N. E. ¼, S. 10, T. 64-8. Rough, mostly massive sericitic schist. Strike not obtainable. Dip 45° S.

This unusual dip is taken on the shore, and I fear the planes of dip are in reality joints. Five rods away, however, the dip is S. 57°. In still another place it is S. 57°.

Some parts of the formation are extremely gravelly.

Rock 246. Gravelly sericitic schist.

HALT 597. S. W. ¼, N. W. ¼, S. 11, T. 64-8. Sericitic schist with disseminated grains and crystals of feldspar and some quartz.

HALT 598. N. W. ¼, S. W. ¼, S. 11, T. 64-8. Argillite a little sericitic, thin-laminated and slaty. Strike N. 73° E. Dip S. 70°.

HALT 599. S. W. ¼, S. E. ¼, S, 11, T. 64-8. Sericitic schist — partly argillitic and partly chloritic, with much interbedding of quartz and a good many lumps of coarsely granular quartz. Formation much like that of 584. Strike N. 86° E. Dip N. 75°.

The beds are much warped, and in places sharply plicated.

HALT 600. N. W. ¼, S. E. ¼, S. 11, T. 64-8. Argillite, dark-bluish, compact, but very distinctly laminated. Strike N. 72° E. Dip S. 54° and 64°. This formation is intersected by a dike of fine diabase, 18 feet wide and bearing N. 57°, and hence cutting the bedding.

Rock 247. Diabase from a dike at Halt 600.

The dike is about vertical.

The formation also includes a bed of coarsely granular quartz mixed with fragments of bluish-black argillite.

Rock 248. Quartz and black argillite.

On further examination this slate-bearing quartz is found in the form of a vein and not a conformable bed. In places it is ten inches wide and conformable, but the branches — still containing fragments of shale — run irregularly across the beds.

Searching further on the contact between the dike and the schist, I find a state of things as follows:

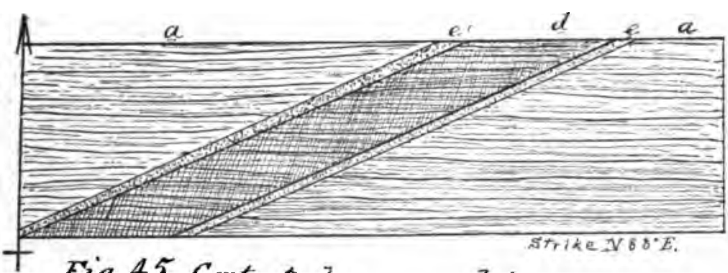

Fig. 45. Contact phenomena between a diabasic dike and argillite, Halt 600, Ensign Lake.

a. Argillite hardened in proximity to the dike.

d. The diabasic dike.

e. A bed 6 inches wide conformable with the dike and having

the appearance of hard, nearly black, argillite, with glistening points similar to those in the contiguous argillite.

e′. A layer similar to *e*, but more diabasic. On the whole, I think *e* and *e′* are a sort of selvage of the dike modified by contact with the argillite; as the contiguous argillite, on the other hand, is modified by the dike in becoming somewhat diabasic — for besides being harder, it is darker and inclines a little to hornblende or augite schist.

HALT 601. N. E. ¼, N. E. ¼, S. 15, T. 64-8. Graywackenitic argillite, compact, non-slaty. Strike N. 82° E. Dip S. 80°.

HALT 602. Centre N. E. ¼, S. 15, T. 64-8. A diabase dike rises like an outlier in the water near the shore, having a trend N. 76° E. conformably with the schists. It is about 27 feet broad. It holds disseminated grains of pale-greenish feldspar, and also a few fragments of glassy quartz. Some of the feldspar fragments are marked as follows:

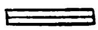

Fig 46. Feldspar individual with line along the middle, from a diabase dike, Halt 602, Ensign Lake

In this greatly magnified figure, a line is seen extending along the middle, giving an appearance as if the crystal had grown from the line in both directions.

Rock 249. Diabase from a dike at Halt 602.

HALT 603. N. W. ¼, N. E. ¼, S. 15, T. 64-8. Sericitic schist distinctly laminated, but not slaty. Some quartz veins. Strike N. 76° E. Dip S. 80°.

HALT 604. N. W. ¼, N. E. ¼, S. 15, T. 64-8. Argillite. Strike N. 74° E. Dip S. 85°. Contains lumps and lenticules of white quartz which warp the bedding more or less, according to size.

§ 22. SUCKER LAKE.

This, as before stated, is sometimes called Birch lake. It is so named on the Canadian map already cited. On a photographed copy of a manuscript map used by the United States Geological Survey, it is marked as Carp lake. It lies along the national boundary next east of Carp lake. Connected with Carp lake by a broad and navigable stream, a quarter of a mile

long, it has a total length of three and one-fourth miles, and an average breadth of half a mile. The eastern end bifurcates, and the southern branch, which contains the channel, is so disguised at its mouth by large islands, that the stranger would be apt to take the northern branch, which is a mere blind bay. It is separated from Pseudo-messer lake by rapids which are passed on a portage about a third of a mile long. Fishing seems to be excellent in Sucker lake, especially about the entrance into the southern arm.

HALT 614. Across the boundary from N. W. ¼, S. E. ¼, S. 1, T. 64-9. Island on Canadian side ("Interlaken"). Sericitic schist, soft, slaty. Strike N. 46° E. Dip vertical.

HALT 615. S. E. ¼, S. E. ¼, S. 1, T. 64-9. Graywacke in a high cliff. It may be bedded, but I could not see the evidence from the face of the cliff. I would suppose it to agree with the graywacke schists in Carp lake, but its composition seems to be hornblende or augite and a feldspar. In contact is a rough argillite.

HALT 616. N. E. ¼, S. E. ¼, S. 1, T. 64-9. Rough argillite, distinctly sericitic under the lens, appearing as if transitional to mica schist. The weathered surface is black and ragged, looking much like a stream of cooled lava, while soft and laminated in hand specimens, the bedding is exceedingly obscured on the weathered surface of the formation,

HALT 617. N. E. ¼, S. W. ¼, S. 6, T. 64-8. Chloritic sericitic schist of very uneven composition, and rough surface. Strike N. 60° E. Dip vertical.

HALT 618. N. W. ¼, S. E. ¼, S. 6, T. 64-8. Sericitic schist, soft, a little argillitic, dun. Strike N. 36° E. Dip vertical.

HALT 619. N. W. ¼, S. E. ¼, S. 6, T. 64-8. Sericitic schist buff and slaty. Dip vertical.

HALT 620. N. E. ¼, S. E. ¼, S. 6, T. 64-8. Sericitic argillite, alternating with sericitic schist, with interlaminations of quartz and some small veins. Strike N. 48° E. Dip vertical.

HALT 621. S. W. ¼, N. W. ¼, S. 5, T. 64-8. Sericitic schist, light-gray surface of laminæ granular. Contains lumps of vitreo-granular quartz, around which the bedding is warped. In one case I see the longer dimension of the lump directed across the bedding, and the laminæ abutting against its sides. Strike N. 40° E. Dip vertical.

HALT 622. N. W. ¼, N. W. ¼. S. 5, T. 64-8. Argillite,

rather hard and compact in the mass. but distinctly slaty. Strike N. 46° E. Dip 84° S.

HALT 623. S. W. ¼, S. W. ¼, S. 33, T. 65-8. Argillite, slaty but rather hard. Strike N. 52° E. Dip vertical.

HALT 624. N. W. ¼, S. E. ¼, S. 33, T. 65-8. Sericitic argillite, rather massive, but distinctly laminated. Contains lumps of quartz, some of which inclose fragments of schist still conformable with the formation. Strike N. 56° E. Dip S. 80°.

HALT 625. N. W. ¼, S. W. ¼, S. 34, T. 65-8. Commencement of portage to Pseudo-messer lake, argillite, blue and slaty. Strike N. 48° E. Dip vertical.

HALT 626. S. E. ¼, N. W. ¼, S. 34, T. 65-8. East end of portage. Argillite, dark, fine, slaty, with some quartz layers. Strike N. 50° E. Dip vertical.

Rock 250. Argillite, fine, dark.

HALT 627. (Canada.) S. E. ¼, S. W. ¼, S. 32, T. 65-8. (As of Minnesota.) Argillite, slate-color and slaty. Strike N. 52° E. Dip S. 80°.

HALT 628. (Wind I. Can.) N. E. ¼, N. W. ¼, S. 32, T 65-8. As of Minnesota. Sericitic schist. Strike N. 22° E. Dip vertical. On the north side of this island it is knotted up with a good deal of quartz.

§ 23. KNIFE LAKE.

Mo-ko-man, or Knife lake, stretches along the national boundary 9¾ miles. It connects with Otter Track lake on the east, and with Pseudo-messer lake on the west; but between it and the latter is an interval of 1½ miles occupied by a stream broken by four rapids and in the intervals expanded into little lakes which, beginning at the east, we have named Potato, Seed and Melon lakes. For convenience of reference and description, Knife lake may be regarded as consisting of the main body and four arms. Arm I is the easterly attenuation of the lake, connecting with Otter Track lake. Arm II extends southeastward in S. 14, T. 65-7, and continues a quarter of a mile into S. 18, T. 65-6. Arm III lies wholly in S. 23, T. 65-7 and trends eastward. Arm IV starts from the northeast corner of S. 28, T. 65-7 and continuing through sections 27, 22, 23 and 24, passes into T. 65-5 and covers portions of sections 19, 18, 20, 21, 17, 16 and 15, having a length of about seven miles, and a breadth varying from a

quarter of a mile to a mile. An arm which might be named Arm IV, protrudes into Canada from the same part of the lake with which Arm II connects.

This lake is commonly approached along the boundary. It may also be reached from Lake Kekekabic by four short portages and three small lakes. The exit from Kekekabic is near the centre of N. E. ¼, S. E. ¼, S. 34, T. 65-7, and the portage leads nearly north a quarter of a mile to Pickle lake. The exit from this is at a shallow bay near the middle of the north side; and the portage leads northwest to the nearest point of Spoon lake, an eighth of a mile From this, at the nearest point to Doughnut lake, is a short portage; and from the most westerly point of the latter lake, is a fourth portage, a third of a mile long, leading west into the nearest part of Arm IV of Knife lake. The locations of these portages are somewhat concealed, and one uninformed will be likely to lose much time in searching for them.

The course of the observations will proceed from Lake Kekekabic over the portages and lakes last mentioned, and westward to Pseudo-messer lake. This route covers all that has been observed by the writer on Knife lake and immediate vicinity.

HALT 875. N. E. ¼, S. E. ¼, S. 30, T. 65-7. On portage to Pickle lake. Outcrop of slates, quite slaty and evidently a transition from the green schists occurring on the shore of Lake Kekekabic at Halt 854, to argillitic chlorite slates.

HALT 876. S. E. ¼, N. E. ¼, S. 34, T. 65-7. N. side Pickle lake. Dark argillite on the beach, and it seems to extend into a long hill stretching N. E. and showing much exposed rock which weathers quite light colored. The slates stands vertical.

HALT 877. S. W. ¼, S. E. ¼, S. 27, T. 65-7. Rough argillitic slate, graywacke-like and veined with quartz. The portage north out of Spoon lake is at the head of a little bay, behind a bit of an island, and concealed by a fallen tree.

HALT 878. S. W. ¼, N. W. ¼, S. 17, T. 65-7. End of portage, on Knife lake. Black, silicious argillite, not very slaty, with much pyrites. Fragments of Ogishke conglomerate and of the green shale on shore, much worn.

HALT 879. S. E. ¼, N. E. ¼, S. 28, T. 65-7. Island. Silicious slate.

HALT 880. N. W. ¼, S. E. ¼, S. 29, T. 65-7. Dark silicious (?) argillite. On close inspection the rock seems more felsitic than silicious. Strike N. 58° E. Dip vertical. Glacial striæ S. 24° W.

HALT 881. S. W. ¼, N. W. ¼, S. 36, T. 65-8. End of portage out of Knife lake. Dark argillite, very slaty, felsitic. Strike N. 73° E. Dip vertical.

HALT 882. On portage from Potato to Seed lake. Argillite. Dip vertical.

HALT 883. S. E. ¼, N. W. ¼, S. 35, T. 65-8. Argillite, continuously slaty.

HALT 884. N. W. ¼, S. W. ¼, S. 35, T. 65-8. Argillite with vertical dip, compact. Strike N. 63° E.

Similar black, silicious slates continue along the shores of Pseudo-messer lake north of the boundary to a distance of at least two miles.

§ 24. IMA LAKE.

It was stated in section 20, when referring to Boot lake and vicinity, that the conspicuous stream shown on the government plat as flowing out of Jordan lake, is much broken by rapids and not canoeable, and no trail rendered practicable the approach to Jordan and Ima lakes from the direction of Snowbank. But a fair trail exists from the eastern extremity of Ensign lake (Halt 600) to Illusion lake. The distance is a mile and a quarter and it strikes Illusion lake on the north side. From the southeastern extremity of this lake, which is less than half a mile long and about a quarter of a mile broad, located in the S. E. ¼, S. 13, T. 64-8, another portage of about an eighth of a mile leads over a ridge of gabbro to Ima lake. Both these lakes are set in a frame of gabbro. Illusion lake is on the transition from schists to gabbro, and some interesting varieties of rock occur, but the general features of the shores of Ima lake are monotonous. For this reason but few halts are indicated, though a large number of exposures were examined. Personally the writer did not visit the north shore.

Ima lake is located chiefly in sections 18, 19 and 20, T. 64-7. It has a length of about two miles and a width of about two-thirds of a mile.

HALT 732. N. W. ¼, N. E. ¼, S. 14, T. 64-8. A few rods on the portage from Ensign lake. Sericitic schist — horizontal, but probably slidden down the hill.

HALT 733. N. E. ¼, N. E. ¼, S. 14, T 64-8. Graywacke. Strike N. 62 E.

HALT 734. End of portage, on Illusion lake, north side. The

rock is obscure. In places it has a diabasic and unbedded aspect; in other places it is distinctly bedded, especially on weathering, and it looks some like nascent mica schist. In many places it is much intersected by veins, and sometimes presents the appearance of the "sewed-up rock."

HALT 735. S. W. ¼, S. E. ¼, S. 13, T. 64-8. Illusion lake. Norite (or gabbro). Coarse, dark, disintegrating; seams composed of labradorite and augite, with a little biotite.

Rock 295. Norite as above.

HALT 736. S. W. ¼, S. E. ¼, S. 13, T. 64-8. Illusion lake. Rock the same as Halt 735. This I suppose to be the rock called gabbro in the northwest.

HALT 737. S. E. ¼, S. E. ¼, S. 13, T. 64-8. Illusion lake. Rock as at Halt 735. Also a rock similar but finer and more like diorite.

HALT 738. Island in Illusion lake, east of a little wooded island. Rock bedded, but the beds are twisted and wrapped to an extreme extent, having on one side a northward dip, and on the other a southward. Most of the rock resembles more or less completely that at Halt 734, but generally it is more altered.

Rock 296. Rock from little wooded island.

Rock 297. Rock from little wooded island, Illusion lake.

These are apparently the constituents of gabbro, but not yet organized — containing also some biotite.

HALT 739. S. E. ¼, S. E. ¼, S. 13, T. 64-8. Ima lake. Termination of portage. The formation, as anticipated, is gabbro. This rock outcrops at frequent intervals along the west shore, and around the little bay at the west end.

HALT 740. N. E. ¼, N. E. ¼, S. 24, T. 64-8. An outcrop of gabbro much rounded by weathering, and in a decaying state.

HALT 741. S. E. ¼, N. E. ¼, S. 44, T. 64-8. Gabbro.

HALT 742. N. E. ¼, S. W. ¼, S. 19, T. 64-7. Gabbro in a huge wall.

HALT 743. S. W. ¼, S. E. ¼, S. 19, T. 64-7. Gabbro.

HALT 774. N. E. ¼, S. E. ¼, S. 19, T. 64-7. Gabbro. A solid wall extends along this shore for the distance of half a mile. Along the eastern shore gabbro outcrops at frequent intervals.

§ 25. THOMAS LAKE.

In the attempt to reach Thomas lake from Ima lake, it was supposed the stream so conspicuously platted might be serviceable, but the outlet at Ima lake was so dimished as to leave

doubt of its real existence. A trail starts out, however, on the section line between sections 17 and 20, T. 64-7, and, in the course of half a mile, leads to a lake two-thirds of a mile long, not indicated on the plat, though appearing to lie on the section line between sections 20 and 21. From the southern extremity of this is another trail of a quarter of a mile, leading to a little lake in the N. E. ¼, N. E. ¼, S. 29; and from this another portage of equal length leading to a little rounded bay not represented on the plat. This is a part of Thomas lake. This lake is located chiefly in T. 64-7, but extends a third of a mile into 63-7. It is a little over two miles long, with a mean breadth of two-thirds of a mile. The lake is hemmed in on all sides by towering masses of gabbro. In consequence of the uniformity of geological character but few halts are noted, though every exposure was adequately examined. The northern shore was not personally seen by the writer—a line of perhaps two miles.

HALT 745. S. E. ¼, N. E. ¼, S. 20, T. 64-7. Swell lake, at end of first portage from Ima lake. Gabbro.

HALT 746. S. E. ¼, N. E. ¼, S. 20, T. 64.7. Swell lake. Gabbro, but finer grained, with much horizontal jointed structure.

Rock 298. Gabbro of finer grain.

HALT 747. S. E. ¼, S. E. ¼, S. 29, T. 64-7. Thomas lake. Gabbro, coarse, decaying—a low outcrop.

HALT 748. S. E. ¼, S.W. ¼, S. 32, T. 64-7. Gabbro. The main mass is coarse as usual, rising in the point and passing beneath water-level. But above this, mostly under water, are plates of fine-grained gabbro, which are washed in large fragments on the beach.

Rock 299. Fine-grained gabbro.

HALT 749. S. W. ¼, S. W. ¼, S 32, T. 64-7. Gabbro with small crystals not homogeneously distributed.

Rock 300. Formative gabbro as above.

Rock 301. Gabbro from Halt 749.

HALT 750. N. W. ¼, S. 4, T. 63-7. Gabbro.

All the windings of the west, south and southeast shores of this lake were carefully examined, and no rock was discovered but gabbro, and little variation was observed in this, except in fineness.

§ 26. FRASER LAKE.

Fraser lake lies in the southeastern quarter of T. 64-7—being mostly embraced in sections 22 and 23, though a long and narrow arm extends into the southern part of sec. 27, and the east end reaches nearly to the middle of sec. 24. The government plat of the lake is exceedingly inaccurate and misleading. The long promontory shown on the southeast side, instead of being broad-based, is so nearly cut off that the water actually connects at certain seasons. The long narrow indentation shown as extending northeastward on the plat, actually extends southeastward, with a long narrow bay running up on the west. Similar misrepresentations exist on the northern border.

The approach to the lake is easy over a broad cut-out portage of a quarter of a mile along the west side of the rapids into Thomas lake. These may be found in S. E. ¼, S. W. ¼, S. 27. The exit toward the east is easily found, and leads to a series of small lakes and short portages into the Little Saganaga. The exit to the north, however, is considerably concealed. In the S. E. ¼, S. W. ¼, S. 14, a short portage exists leading into a lake which the survey named Wisini, two-thirds of a mile long, but not indicated on the plat. No portage or trail, however, leads out of this lake, and the survey was compelled to cut one N. N. E. into a little lake which was called Syrup lake. From the northern extremity of this another portage was cut, half a mile long, N. N. E. into Shoo-fly lake, which lies mostly in the S. E. ¼, S. 11. Near the northern end of this, a short, dry, much-used portage leads westward into a river-shaped lake, thence named River lake, from the northern side of which at the elbow, a poor portage a third of a mile long, leads north into the most southern point of Kekekabic. It is probable Shoo-fly lake may be reached directly from Fraser lake, over a portage which escaped our observation.

These lakes all rest in depressions of a great gabbro formation. On the northeast of Fraser lake, the hills of gabbro rise 70 or 80 feet above the lake. It is in this formation, as I am informed, that gold was reported to exist. The mine for a time so famous, is located on the north shore, in S. E. ¼, S. W. ¼, S. 14, T. 64-7.

From the uniformity of the geology, only a few localities will be specifically noticed.

HALT 751. N. E. ¼, S. W. ¼, S. 27, T. 64-7. Southern point of Fraser lake. Gabbro in a massive exposure. This is where

the road strikes this lake which we find cut out most of the way from Carp lake — a winter road for transportation to Fraser lake.

Here on the beach are fragments of silico-argillitic slates.

HALT 752. About S. 23, T. 64-7. This Halt can not be precisely located in consequence of the great imperfection of the plat. The great point from the southeast shore is deeply constricted near the base — quite unlike the plat. This isthmus is not over four rods wide, and is covered in high water.

On this I found large fragments of silicious argillite.

A very massive outcrop of gabbro extends along the eastern shore of the lake north of the promontory.

The modifications made in this part of the plat could only in part be represented on the map accompanying this report.

Wisini lake is quite walled in by massive outcrops of gabbro.

Syrup lake is surrounded by a marsh, except on the north side.

Shoo-fly lake is surrounded by upland on all sides.

Much of the territory about Fraser and contiguous lakes has been burned over. Most of this is now covered by a dense growth of young aspens.

HALT 753. S. W. ¼, N. E. ¼, S. 11, T. 64-7. "Muscovado gabbro," but with a few disseminated grains of reddish feldspar giving the rock a slightly syenitic aspect.

"Muscovado" is a term here applied to a finely granular gabbro or gabbroloid having accessions of reddish feldspar as above noted, as well as a few disseminated grains of quartz.

This locality is on the north side of River lake near the passage north into the broad parallel arm.

An outcrop of the same occurs on the north side of the north arm a few rods east of the portage.

§ 27. KEKEKABIC LAKE.

The principal area of this lake lies in towns 64 and 65-7, but a portion of the elongated eastward extension covers parts of 29, 30, 31 and 32, T. 65-6. Its longitudinal axis is 4¼ miles long and trends N. 70° E. It lies in a broken country, and several rounded summits rise from 100 to 200 feet above the lake. Its shores possess much geological interest as showing the transition from the gabbro region of Fraser lake to the black slates of Knife lake.

It affords the first glimpse, also, of a remarkable conglomerate which, further east, attains a great development, and receives the name of Ogishke Conglomerate.

We were unable to take any fish in this lake with the ordinary trolling hook.

HALT 754. S. W. ¼, S. E. ¼, S. 2, T. 61-7. Rock weathering reddish, and when broken appears to contain a dark mineral having a chloritic aspect, and giving the whole a banded texture.

Rock 302. Chloritic gneiss.

HALT 869. S. W. ¼, N. W. ¼, S. 2. T. 64-7. Only fragments, and not all of one sort. Many of reddish chloritic gneiss, like that seen along the south shore.

HALT 870. S. E. ¼, N. E. ¼. S. 3, T. 64-7. East end of Plum island. Rock of red feldspar and a dark chloritic substance with probably considerable quartz. Exceedingly tough. The constituents vary in different parts and show a banded arrangement.

Rock 377. Felsitic schist.

HALT 755. N. W. ¼, N. W. ¼, S. 2, T. 64-7. Seems to be essentially feldspar, chlorite and quartz, and is consequently the same rock as began to appear at Pipestone rapids. (Halts 640 to 655.)

Rock 303. Compact, chloritic gneiss.

HALT 871. West end of little island in N. W. ¼, N. W. ¼, S. 2, T.-64-7. Rock essentially like that at Halt 870, but containing large crystals of feldspar.

Rock 378. Porphyritic, chloritic gneiss.

HALT 872. North side of same island. Here the green and the feldspathic ingredients instead of being blended into a gneiss, remain separate in bands.

Rock 379. Green rock and granulitic interbanded. The green portion is not distinguishable from the green rock occurring at numerous places, and I feel confident that it is essentially chlorite, and the dark shining scales are chlorite.

This formation presents a rude, nearly horizontal bedding.

HALT 756. S. E. ¼, S. E. ¼, S. 35, T. 65-7. Chloritic gneiss, similar to Rock 303, but the orthoclase occurs in larger grains, from a sixteenth to half an inch in longest dimension. The forms and positions of these grains indicate a bedded influence in the rock.

Rock 304. Compact, chloritic gneiss, coarser grained.

HALT 757. N. E. ¼, S. W. ¼, S. 36, T. 65-7. West end of Stacy island. This seems to be essentially the same sort of rock in which the feldspar has accumulated in a porphyritic fashion. This sort of porphyry is what I subsequently designated "porphyrel." It contains here small black scales of apparently chlorite.

Rock 382. A small piece of this porphyrel showing indication of conglomeritic constitution.

Rock 305. Chloritic porphyrel.

HALT 758. On south side of Stacy island. Cliffs sixty feet high, broken down vertically. Rock is bedded somewhat obscurely. Strike N. 53° E. Dip N. 85°. Formation consists of gneissic beds similar to those last described, alternated with dark—perhaps slightly greenish, but distinctly blackish—heavy beds having a slaty aspect.

Rock 306. Slate, compact, argillitic, as above, with some feldspar crystals.

HALT 759. Near eastern end of Stacy island. At the bottom of the bluff a well-marked conglomerate rises above water-level. It weathers rough, is slightly brecciated, dark colored, composed of fragments of fine diabase, dark silicious schist, red jasper, black flint, all imbedded in a fine matrix of dark color, looking somewhat like the overlying dark slate. The conglomerate dips N. 70°, with a strike N. 52° E.

The conglomerate is apparently conformable with the overlying formation, and passes upward into it through the intervention of a partial conglomerate and rough, uneven bed.

Rock 307. Conglomerate from Stacy island.

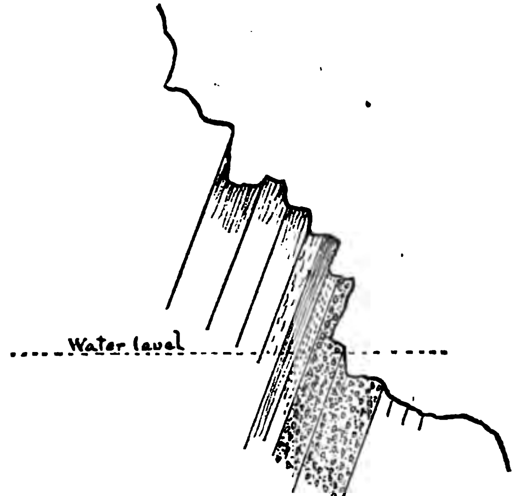

Fig 47. Subterposition of conglomerate, Halt 759, Stacy Island, Lake KekeKabic.

On the main shore nearly opposite, and extending eastward, are cliffs eighty feet high, composed like Stacy island, of dark, very compact schist, and having conglomerate at water-level.

HALT 760. S. W. ¼, N. W. ¼, S. 31, T. 65-6. Compact, diabase-like groundmass, with disseminated, rectangular crystals of feldspar.

Rock 308. Porphyritic, diabase schist.

HALT 761. S. E. ¼, N. E. ¼, S. 30, T. 65-6. Compact, porphyritic diabase.

Rock 309. Porphyritic diabase.

Back from the shore a bluff rises, composed of a fine, slate-colored rock, distinctly bedded and resembling the compact slate of Stacy island. The dip, if I do not mistake, is N. 35° and the strike is N. 28° E — both quite anomalous.

I attempted to find the relation of the slate and the diabase; and, climbing to the top of the cliff, found a mass of the diabase which I traced down to a level ten or fifteen feet below the occurrence of slate, and hence I inferred that it intersects the slate. In fact, I uncovered almost to the plane of contact. I was thus led to think the diabase erupted. Thirty feet west, however, actual contacts were easily seen, but they are not dike-like. Fragments of the diabase occur within the

slate, and the transition between them is not abrupt, but gradual. The slate, however, in the vicinity, is hardened and diabasic.

Rock 310. Dark slate, silicious.

Rock 311. Slate-colored slate, softer.

Rock 312. From a dike across the slate.

HALT 762. S. E. ¼, N. E. ¼, S. 31, T. 65-6. Shale, hard, varying from a slaty condition to a diabasic. I find the diabasic portions included in the slaty. The slaty structure is vertical and strikes N. 13° E.

HALT 763. S. W. ¼, N. W. ¼, S. 32, T. 65-6. Fine, hard, brittle diabasic rock, with a subslaty structure.

HALT 764. N. W. ¼, N. W. ¼, S. 32. T. 65-6. Fine, hard, bluish-slate, weathering light. The most conspicuous slatiness is nearly horizontal, but plates split also in a vertical direction; and this vertical cleavage seems to be coincident with the bedding.

Rock 313. Fine, hard, bluish slate.

HALT 765. S. E. ¼, S. W. ¼, S. 29, T. 65-6. Diabasic slate.

HALT 766. S. E. ¼, S. W. ¼, S. 29, T. 65-6. At portage eastward. Diabasic slate. A large and lofty exposure. There seem to be sedimentary bedding planes standing nearly vertical, and having strike N. 23° E. There is also an extensive set of planes of schistosity striking N. 87° W.

Ascending the hill on the west I find the slatiness of the formation not much apparent except in weathering. I find many intrusions of diabase and porphyritic material, sometimes in the form of dikes, sometimes by mixing with the slate and being included in it.

On the summit, which is perhaps 100 feet above the lake, I find the strike N. 38° E., and the dip S. 85°. The glacial striæ are S. 18° W.

HALT 845. S. E. ¼, S. W. ¼, S. 29, T. 65-6. Porphyrel quite distinctly conglomeritic.

Rock 362. Porphyrel from Halt 845.

HALT 846. S. E. ¼, S. E. ¼, S. 30, T. 65-6. Foot of Mallman's peak. Graywacke-like and silicious slate.

Rock 363. Graywacke-like.

The formation presents portions which are almost sericitic.

Mallman's peak, as ascertained by aneroid, is 230 feet high — above the lake.

A sample of the rock from the summit is not different from the gray rock at the base.

HALT 847. N. E. ¼, N. E. ¼, S. 31, T. 65-6. Two fragments of a dike rise above water off foot of Mallman's peak, ranging S. 2° W., and about 15 feet in diameter. Slate is seen in contact with it on east and west.

Rock 363. Dike rock from Halt 847—diabase.

HALT 848. N. E. ¼, N. W. ¼, S. 31, T. 65-6. High cliff of hard slate breaking down in square columnar forms.

HALT 843. S. W. ¼, S. W. ¼, S. 29, T. 65-6. Promontory composed of the rock which I have designated porphyrel. It is quite similar to the rock at Halt 842, in Zeta lake—to be mentioned hereafter. It contains many crystals of feldspar, which lie with their longer axes in same direction. Some of the pieces (individuals) also are rounded, and present the curious property of radial reflections. Some have a definite crystalline form in the centre, with an imperfect crystalline envelope. Some hold a dark mineral, apparently hornblende or chlorite, in the centre. The rock contains also green, chlorite-looking lumps and dark, eight-sided prisms—also some traces of epidote. The rock further includes pebbly forms obscurely isolated and themselves porphyritic.

Rock 360. Porphyrel from Halt 843.

HALT 844. S. W. ¼, S. W. ¼, S. 29, T. 65-6. Head of little bay at foot of Mallman's peak. The rock here is also porphyrel, but the groundmass is more granular and contains disseminated quartz. One large crystal of feldspar is noticed, which contains in the centre an aggregation of small crystals of a dark-greenish mineral. Inclosed in the formation are beds and lenticules of highly-altered slate, and the formation exhibits a rudely-bedded state.

Rock 361. Porphyrel from Halt 844.

HALT 849. N. E. ¼, N. W. ¼, S. 31. T. 65-6. Green crystalline rock with black specks. Probably similar to next, but less bedded.

HALT 850. N. W. ¼, N. W. ¼, S. 31, T. 65-6. Green chloritic schist—uniform in color and composition—distinctly stratified. Strike N. 68° W. Dip vertical.

Rock 364. Chlorite schist.

HALT 851. N. E. ¼, N. E. ¼, S. 36, T. 65-7. A little east of narrows. Porphyritic boss at the angle of north shore. Contains a superabundance of elongated feldspar crystals—a light grayish-green groundmass, some green crystals appearing like hornblende in transformation to mica. Much of the porphyry weathers red-

20

dish. There is no quartz. I see again a feldspar crystal with a globule of green mineral in the centre. The rock contains frequent subangular fragments of a green rock which itself has an erupted aspect—in fact is exactly like the Ogishke greenstone, found on a mountain south of Campers' island.

Rock 365. Porphyrel from Halt 851.

Back of this bluff is a ridge which is at first heterogeneously porphyritic and unporphyritic—in places a green rock (366)—and then passing toward the summit into hard banded slates.

Rock 366. Green rock in ridge back of Halt 851.

HALT 852. N. E. ¼, N. E. ¼, S. 36, T. 65-6. Here a boss of conglomerate with a green groundmass rises above the surface, and the porphyrel of Halt 851 rests upon it on the east and west, thus:

Fig. 48. Relation of conglomerate and por-phyry at Halt 852, Kekekabic Lake.
It is still possible this porphyry may prove to be stratified.

The greenish rock is the same as Rock 366, in which I did not notice any pebbles.

Rock 367. Chloritic conglomerate.

HALT 853. N. W. ¼, N. E. ¼, S. 36, T. 65-7. Chloritic slates. Dip W. 80°.

HALT 854. N. E. ¼, S. E. ¼, S. 34, T. 65-7 (approximately). Slates appear on the beach.

Back from the beach green schists are again seen, and these are conglomeritic in occasional bands.

Rock 368. Green conglomeritic schist.

The slates on the beach are about the same.

HALT 855. N. W. ¼, S. E. ¼, S. 34, T. 65-7. Slate. Strike N. 52° E. Dip vertical.

HALT 856. N. W. ¼, S. E. ¼, S. 34, T. 65-7. Slate argillitic. Dip about vertical.

HALT 857. N. E. ¼, S. W. ¼, S. 34, T. 65-7. Green bedded rock like that at Halt 854. It also presents a conglomeritic appearance in some of the beds. The dip—if I have not mistaken it—is W. 75°, but there is much uncertainty about it. A few rods west, the dip of the schists seems to be vertical.

Rock 369. Green conglomeritic schist.

HALT 858. N. E. ¼, S. E. ¼, S. 34, T. 65-7. The point just mentioned. The mean attitude of the beds is vertical, and they are curiously eroded by the water — having open arched spaces.

HALT 859. N. E. ¼, S. W. ¼, S. 34, T. 65-7. Rock of same external aspect as last, even to greenish color; but it is hard and dark-gray when broken.

HALT 860. N. W. ¼, N. W. ¼, S. 3, T. 64-7. Fine, dark, silious argillitic schist, but strike and dip indeterminate.

HALT 861. N. W. ¼, N. W. ¼, S. 3, T. 64-7. Fine, dark silicious argillite, less flinty than at Halt 860. The bedding in a part of the exposure is very distinct and slaty, and gives strike N. 48° W. and dip 50° N. E. There is also a schistosity which strikes N. 42° E.

HALT 862. S. W. ¼, N. W. ¼, S. 3, T. 64-7. Fine granulitic schist, composed mostly of reddish feldspar and a little quartz with streaks of epidote, and some blotches of dark chloritic rock included.

Rock 370. Fine reddish, granulitic schist.

HALT 863. Ten rods north of 862. Rock intermediate between that of 861 and 862.

Rock 371. Granulitic schist or gneiss, with distinct grains of reddish feldspar and a greenish coloring matter. No mica. Compare with Halts 753, 754 and 755.

HALT 864. N. E. ¼, S. E. ¼, S. 4, T. 64-7. Gabbroloid rock, greenish-gray, weathering very rough — the surfaces looking conglomeritic, but not truly so. Mass of rock consisting of small, grouped, greenish laminæ. Can not determine whether it is feldspathic or chloritic.

Rock 372. Gabbroloid rock.

HALT 865. S. W. ¼, S. W. ¼, S. 3, T. 64-7. Essentially the same as at Halt 864, but not weathering so rough. Has the weathered aspect of gabbro.

Rock 373. Gabbroloid. Is more distinctly crystalline than 372, and more gabbro-like.

HALT 866. S. E. ¼, S. E. ¼, S. 3, T. 64-7. Rock seems composed largely of reddish, granular feldspar, with some quartz. There is also some black mica present, and finally, an undefined greenish constituent.

Rock 374. Gneissic rock.

HALT 867. S. W. ¼, S. W. ¼, S. 2, T. 64-7. Only fragments on shore, but they are all of one kind. Composed of reddish feld-

spar, quartz and a chlorite-like mineral, with some mica. Contains numerous dark-green fragments.

Rock 375. Chloritic geniss.

HALT 868. S. E. ¼, S. W. ¼, S. 2, T. 64-7. Rock composed of red and pale-dun feldspars. Quartz, if present, not detected. Mica wanting and the greenish mineral is wanting.

Rock 376. Subgranular felsite.

§ 28. OGISHKE-MUNCIE LAKE.

From the eastern extremity of Kekekabic to Ogishke-muncie is only a little more than a mile and a half, but the route of travel is about two miles and a half, and passes over seven small lakes and eight short portages. The lakes have been named in succession, Alpha, Beta, Gamma, Delta, Epsilon and Dike lakes, lying in the southwestern part of T. 65-6. Epsilon is the most considerable, having an east and west length of a mile and a quarter; but only the eastern extremity lies in the route. It approaches very near the IVth Arm of Knife Lake, and is connected by a portage. Zeta lake is next in importance, having a length of a mile, and in one part, a breadth half as great. These little lakes are nested in basins of massive conglomerate alternating with hard slates mostly argillitic and graywackenitic.

Ogishke-muncie is a very irregular lake lying mostly in the southern half of T. 65-6. Its main axis trends N. 30° E. and its length is 3½ miles—the whole length of the lake being four miles, and its mean breadth about a third of a mile. In S. E. ¼, S. 23, it is contracted to a sixteenth of a mile. Just west of the narrows is Campers' island, so named from its extensive use for camping purposes. Originally covered with small Norway and Jack pines, these have been almost completely exhausted for fuel.

The features of the land are decidedly bolder than about the western lakes. Ranges of conglomerate obscurely bedded rise on many shores in imposing masses; and these are, on the northwest borders, conspicuously interbedded with vertical sheets of hard argillite. On the north these rocks attain an altitude of a hundred feet. On the south they are succeeded, in the more lofty ranges, a few miles back, by a green formation, here called "greenstone;" and still further back in the highest hills, by an enormous overflow of gabbro.

The country is uninviting to agriculture. Bare, broad, dome-

shaped expanses of conglomerate are separated by narrow tamarack swamps, and the soil-covered slopes are occupied by aspens, which in places certainly have supervened on extensive burnings. The interior was explored on the north and the south to the distance of about two miles, and many careful and deliberate observations were made along all the shores.

HALT 767. N. E. ¼, S. W. ¼, S. 29, T. 65-6. North end of Alpha lake. Rock similar to that at Halt 766, but perhaps weathering a little more slaty. In fact it may probably be styled a silicious and metamorphic argillite.

The portage to Beta lake is about 30 rods.

HALT 768. Near centre S. 29, T. 65-6. Same formation, but more distinctly slaty. Some parts, when broken, are well-characterized argillite. Strike N. 52° E. Dip vertical.

In the bluff near by, the formation weathers into chips by the increase of the slaty matter interposed between the layers of the more silicious and feldspathic matter.

HALT 769. S. E. ¼, N. E. ¼, S. 29, T. 65-6. Graywackenitic slate, intersected by veins of quartz and of chloritic material.

HALT 770. S. E. ¼, N. E. ¼, S. 29, T. 65-6. Portage to Gamma lake. Rock very similar to that at Halt 766. Very distinct alternating bands, more and less slaty. Strike N. 34° E., sinuous. Dip vertical.

This portage is 20 rods long, but rough and difficult.

HALT 771. S. E. ¼, N. E. ¼, S. 29, T. 65-6. Portage to Delta lake. The rock continues as at Halt 766—a graywackenitic slate, hard, compact, jointed, but distinctly bedded.

HALT 772. N. W. ¼, N. W. ¼, S. 28, T. 65-6. Graywackenitic argillite, with some of the beds quite perfectly a slate, and others granular.

Rock 314. Argillite from Halt 772.

HALT 773. S. E. ¼, S. W. ¼, S. 21, T. 65-6. Portage out of Delta lake. Fine hard argillite, rather slaty. I find some good for whetstones. Strike N. 14° E. Dip N. 75°.

HALT 774. N. E. ¼, N. W. ¼, S. 28, T. 65-6. Portage out of Epsilon lake. Slates similar to the recent observations.

HALT 775. Centre S. 28, T. 65-6. Porphyry, extending for at least four rods along the beach. An earthy green base tolerably compact, filled with whitish feldspar crystals.

Rock 315. Porphry. (Porphyrel.)

HALT 776. Six rods north of Halt 775. A dark rock apparently eruptive—but probably not completely so—lying at wa-

ter's surface, and rising five feet above, having a decidedly diabasic look. It rises in a vertical wall.

Above this, porphyry, some with reddish feldspar. It seems to have overflowed the diabase—assuming the structure of nearly horizontal beds. But still I can not be certain that this is an overflow. Further on, the porphyry comes down to the water's edge.

Rock 316. Porphyry with reddish feldspar.

Rock 317. Diabase? under porphyry.

HALT 842. S.W. ¼, N. E. ¼, S. 28, T. 65-6. Zeta lake, north side of narrows, near Halt 776. Here is a porphyry-like rock having, like that at Halt 776, all the general appearance of an ordinary porphyry. Nevertheless, it contains traces of foreign fragments. The base is not completely homogeneous. Here especially can be seen hornblende somewhat extensively disseminated.

Rock 359. Porphyry-like rock.

A careful study of the rock under the lens shows that it is crystalline, with a fine, dark-green base or groundmass. Moreover, the rock seems to be rather the groundmass simply of the conglomerate of the region—that is, an aspect of the wide-spread Ogishke Conglomerate. This groundmass *may* differ in some important respect from the groundmass of the conglomerate north of Campers' island, which, undoubtedly, is a bedded rock, and, in all probability, a sedimentary rock, though highly metamorphosed; still, I do not discover as yet any important differences. I incline to think both rocks frgamental primordially, and the porphyritic characters here and elsewhere seen, as superinduced by metamorphism, secondarily. I see no objection to regarding some of the feldspar fragments as sedimentary, and the quartz grains as largely so; but this does not preclude the porphyritization of portions of the rock adapted to that change.

According to my view this rock was not originally molten. It is not an eruptive rock. It is not, therefore, a typical porphyry. It bears obscure marks of sedimentation—even of conglomeritic accumulation; yet it is distinctly and typically porphyritic. It is not a porphyritic conglomerate, for the conglomeritic character is the least observable feature. It is not a purely sedimentary accumulation of individuals of feldspar in a primitive mud, for too many of the crystals retain their angles unimpared. We need again some new designation, and I will, at least provisionally, use the following:

PORPHYREL — A diminutive of porphyry. A rock having a porphyritic aspect, but without a homogeneous, feldspathic base — not primitively erupted, like porphyry, but originally sedimentary, or, at least, igneo-aqueous in origin, and secondarily, subjected to powerful metasomatic action, involving especially feldspar-development.

I incline to the opinion that nearly or quite all the "porphyry" associated with the schists and conglomerates of this region possess the character of porphyrel.

HALT 777. N. E. ¼, S. E. ¼, S. 28, T. 65-6. Entrance to Dike lake. Slate, dark slate color, compact but argillitic. Strike N. 17° E. Dip vertical. Back from the beach rises a hill composed of conglomerate. The pebbles consist of granite, diabase, flint and a greenish aphanitic rock; and there is a groundmass of diabasic or graywackenitic material. In parts of the conglomerate are disseminated grains of glassy quartz, giving the rock a porphyritic appearance; and on the weathered surfaces, white feldspathic grains come into view, strengthening the porphyritic indications. The feldspar can also be seen in some fresh fractures as ill-defined nuclei.

Rock 318. Conglomerate from Halt 777.

Rock 319. Porphyritic conglomerate.

The different portions of the conglomerate are readily scratched with the knife. The pebbles are mostly with rounded angles. Some attain a diameter of ten inches. Some are themselves porphyritic with quartz.

The weathered surface everywhere exhibits what I feel constrained to regard as *flowage lines*. Fibres and sheets are wrapped around the pebbles. The longer axes of the pebbles do not lie in any fixed direction. I can not detect any general bedding planes, though joints intersect the formation chiefly in two directions, N. 48° W. and N. 11° W. There is also a tendency to rude horizontal bedding.

Proceeding to the summit of this hill, I find some indications of bedding which strike N. 42° E. and dip south 80°.

The pebbles are arranged in courses alternating with belts containing much smaller pebbles. These bands are many times repeated.

Some of the groundmass has every appearance of diabase, quite like that under the porphyry at Halt 776.

Rock 320. Diabasic groundmass of conglomerate.

Some of the pebbles are themselves porphyry, resembling the porphyrel at Halt 777.

The contact between the slate and conglomerate is not abrupt, but by steps, somewhat as shown by the following figure:

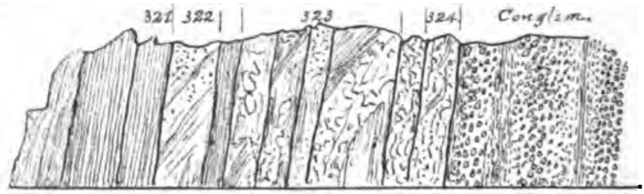

Fig. 49. Contact of slate and conglomerate at Halt 777, Dike Lake

The numbers refer to the rock-series of the Report.

The view is taken looking southeast. The strike is N. 22° E. On the north is the characteristic slate (321). Next, slate mixed with porphyritic material. (In 322 it is granitic.) Then a graywackenitic mass with often faint outlines of pebbles (323). Next, more distinct pebbly outlines with still some slate (324). Lastly the well-developed conglomerate.

Rock 321. Slaty, micaceous argillite.

Rock 322. Slate and granular rock.

Rock 323. Slate with outlines of pebbles.

Rock 324. Black, silicious argillite. Halt 778.

HALT 778. N. W. ¼, S. W. ¼, S. 27, T. 65-6. Portage from Dike lake. Dark slates standing vertically. Strike N. 30° E. Dip N. 85°.

HALT 787. S. E. ¼, S. W. ¼, S. 27, T. 65-6. Ogishke-muncie lake. Slate. Dip S. 65°.

HALT 788. S. W. ¼, S. E. ¼, S. 27, T. 65-6. Conglomerate, but having a different aspect from that on north shore. The groundmass is a brighter green. Many of the pebbles are of similar material. The pebbles are more angular and less distinctly defined.

HALT 789. N. W. ¼, S. E. ¼, S. 27, T. 65-6. Conglomerate like that at Halt 788.

HALT 790. N. E. ¼, S. E. ¼, S. 27, T. 65-6. Almost a strict diabase, but in portions containing rounded pebbles, mostly not very distinctly isolated. The rock seems to be a superfluous supply of groundmass.

HALT 791. N. E. ¼, S. E. ¼, S. 27, T. 65-6. Same as at Halt 790.

HALT 792. N. W. ¼, S. W. ¼, S. 26, T. 65-6. Conglomerate with rounded pebbles, the whole rock having a diabasic aspect.

HALT 793. S. W. ¼, N. W. ¼, S. 26, T. 65-6. Rock looking like a mass of greenstone — breaks and weathers like it — but the outlines of pebbles can be traced in many places, and there are lines of bedding obscurely visible. It is truly diabasic in outer appearance, but seems to have resulted from the softening of a conglomerate.

HALT 794. S. E. ¼, N. W. ¼, S. 26, T. 65-6. Diabasic conglomerate still. Plenty of large rounded pebbles traceable on weathered surfaces.

HALT 795. N. E. ¼, S. W. ¼, S. 26, T. 65-6. Black slate much crumpled and baked. Strike N. 22° E. Dip S. 80°.

HALT 811. N. E. ¼, S. W. ¼, S. 26, T. 65-6. Across the rapids from 795. Much altered, dark argillites appearing in the bluff — the continuation of those at Halt 795. They are here intersected by an abrupt transition to rock which appears to be erupted.

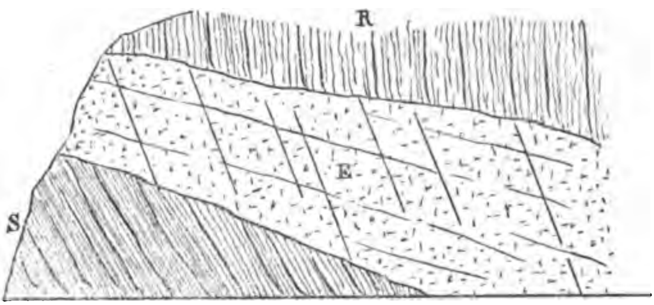

Fig. 50. Appearance of a dike, Halt 811, Ogishke-muncie Lake.

S, slate; E, supposed dike; R, slate from vicinity with same strike as S, but different dip. Figure partly theoretical.

The above is a view of the face of the bluff somewhat in perspective. S represents the slates striking N. 52° W, and dipping N. E. E is the eruptive rock, cutting off the strata of S as if it were a dike. On the top of the hill, four or five rods from S, the slate reappears with a strike N. 37° E. The above cut represents nearly a horizontal projection of the exposure. The

natural inference is that this eruptive rock is a dike. That it has locally disturbed the strata is shown by the evident discorddance of S and R, and also by the fact that the shales two or three rods further west, have a strike N. 28° E, with a dip rather south of east, which is about normal and agrees with the observations at Halt 795.

Rock 339. Eruptive rock, Halt 811.

Rock 340. Slate, Halt 811.

HALT 796. S. E. ¼, N. W. ¼, S. 26, T. 65-6. Little island. Sericitic schist, very ferruginous and quite chloritic.

HALT 797. N. W. ¼, N. E. ¼, S. 26, T. 65-6. Diabasic conglomerate.

HALT 798. S. W. ¼, S. E. ¼, S. 23, T. 65-6. Sericitic schist again, but it graduates by nameless transitions into the prevailing diabasic conglomerate.

This completes the proof that the slates and conglomerate belong to one formation, and that they are a prolongation from Vermilion lake.

Rock 326. Diabasic groundmass from Halt 786.

Rock 327. Interlaminations of slate and groundmass, Halt 786.

Rock 328. Green diabasic groundmass, Halt 788.

Rock 329. Diabasic groundmass from Halt 790.

Rock 330. Sericitic schist from Halt 796.

Rock 331. Sericitic, chloritic schist from Halt 798.

Rock 332. Sericitic, first, gradation toward diabase.

Rock 333. Sericitic, second, gradation toward diabase.

Rock 334. Sericitic, third, gradation toward diabase—the change complete.

The specimens 331-334 were collected within four feet of each other. There is a point of a hill which at the extremity is sericitic, but this for a thickness of three feet only. The rock crumbles to chips and resembles in every way the sericitic schists seen at Vermilion lake. Just back, and at a higher level, the rock is more solid. A little further back it is still more solid, and looks much like a massive chlorite rock (333). Finally, the well-marked groundmass rock appears and constitutes the bulk of the exposure (334).

HALT 779. S. E. ¼, S. W. ¼, S. 23, T. 65-6. CAMPERS' ISLAND. Conglomerate.

HALT 780. N. E. ¼, S. W. ¼, S. 23, T. 65-6. Opposite Campers' island, north side. Conglomerate, but very extraordinary.

The formation is cut up by joints, as if an erupted rock. Groundmass is the principal part. It is composed of two varieties of feldspar and considerable quartz in disseminated grains.

Ascending to the summit of this cliff I find evidences of bedding, and I think they are unmistakable. They consist in the alternating arrangement of the materials. They show a Dip S. 65° and a strike N. 42° E. Toward the top the pebbles are more abundant and more isolated from the matrix, but this can hardly have any significance. In some beds they lie as thick almost as possible.

HALT 781. S. E. ¼, S. W. ¼, S. 23, T. 65-6. Conglomerate not notably different from that at Halt 780. This, however, is much broken down, forming a massive talus.

HALT 782. N. W. ¼, N. W. ¼, S. 26, T. 65-6. Dark argillite, well characterized. Strike N. 47° E. Dip nearly vertical.

On the northwest occurs the conglomerate. The slate in the vicinity for two or three rods is a little more rough. The junction is perfectly abrupt, and continues on an almost rigidly straight line from the shore for ten rods back. On the surface, the appearance is like this:

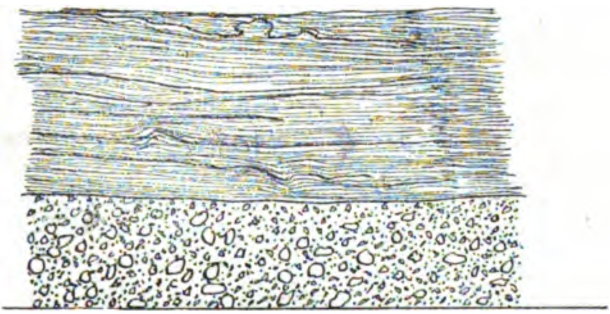

Fig. 51 Junction of slate and conglomerate Halt 782, Ogishke-muncie Lake.

Looking N. 43° *W.*

On the west side of this headland occurs again the junction between the slate and conglomerate. The island in the narrows to the little bay is conglomerate.

HALT 783. N. W. ¼. N. E. ¼, S. 27, T. 65-6. Conglomerate. Contains a good amount of red and banded jasper.

HALT 784. N. W. ¼, N. E. ¼, S. 27, T. 65-6. Conglomerate.

HALT 785. S. E. ¼, N. W. ¼, S. 27, T. 65-6. Conglomerate.

In courses, the pebbles are very abundant, but much of the rock is a massive diabase-like material, having the aspect of a huge dike; but the pebble-courses run directly through it, with a dip S. 80°.

The dips in this vicinity are such that the schist-beds assume a position above the conglomerate, and hence, in the absence of inversions, would be newer.

HALT 786. S. W. ¼, N. W. ¼, S. 27, T. 65-6. Slate and conglomerate. On the shore the rock is chiefly the groundmass of the conglomerate. Then succeed slates—then well-marked conglomerate. The groundmass rock contains a few obscure pebbles.

This occurrence of slate being further north than some observed conglomerate, a recurrence is indicated. It is very evident, however, that beds of slate and conglomerate exist in numerous alternations.

This completes the circuit of the lake. I now present the results of some observation made on excursions to the north and south of the lake in the vicinity of Campers' island.

From this island, looking southward, a range of hills is seen which may be estimated at 300 feet high. The route pursued started from the head of the little bay, Halt 795.

HALT 799. About ten rods back from the point. The slate is almost flinty. Side by side with it are beds of a diabasic-looking schist.

HALT 800. 20 rods back. Strike N. 20° E. Highly baked argillite. Dip vertical.

HALT 801. 30 rods back. Highly baked argillite, and side by side with it, showing bedding, a slate porphyritic with feldspar and glassy grains.

Rock 335. Porphyritic schist from Halt 801.

HALT 802. About a half mile back. Contorted slates, dipping 60° E. with a strike N. 33° W.

HALT 803. On the lower shoulder of the mountain. Bedded, highly metamorphic slates continuing in alternation. Strike N. 12° E. Dip S. E. 80°. Adjoining this on the south the schists are a little sericitic and crumbling to chips.

HALT 804. Northern slope of valley following Halt 803. Same rock, with Strike N. 23° W., undulating. The strike of the ridge is N. 32° E., and the previous ridges have a similar strike, and this is nearly the prevailing strike of the formation. This rock is somewhat more flinty than the preceding.

HALT 805. Beginning of second from last ascent. Similar schist, but with strike N. 78° W. Dip vertical. Beds much contorted. Close by, the dip is westerly 45°. These irregularities show marked disturbance.

HALT 806. First ridge north of assumed summit. Strike of schists N. 67° W. Dip 45° westerly.

HALT 807. Ridge next the summit. Strike much broken up. Here are great masses of conglomerate with doleritic groundmass.

HALT 808. On the last ascent. The altered slates are seen in contact with a green doleritic rock itself containing pebbles. The slates strike N. 68° W., with a dip N. 50°. The relations are shown in the following figure:

Fig. 52. Relations of the "green rock" and slates south of Ogishke-muncie Lake.
Looking West.

Rock 336. Green rock.

HALT 809. At the summit. The green rock is more clearly developed. It is composed of grouped lamallæ of a greenish color and rather soft. This appears much like chlorite. Even this rock contains pebbles to a limited extent. Some are diabasic and some flinty.

Rock 337. Green rock from the summit.

This hill is made, by aneroid, 240 feet above the lake. But half a mile further south a hill appears which seems to be as much as 100 feet higher.

HALT 810. A few rods east of Halt 801. Outcrop of porphyritic rock near Fox lake. [See Halt 811, after 795.]

Rock 338. Porphyritic rock. Halt 810.

The following are localities on a tour to the high hill northwest of Campers' island:

HALT 812. One-quarter mile north of north shore. The usual conglomerate.

HALT 813. One mile north of lake. A knob of the conglomerate appears porphyritic, but it contains grains of red jasper and of flint and quartz, besides crystals and grains of feldspar; and it may probably be regarded a compacted mass of gravel derived mainly from the disintegration of granite. It contains also a few grains and small pebbles of carbonaceous slate. On the whole, it is only a finer condition of the conglomerate. There is a little matrix material of a greenish color, which appears composed largely of smaller grains of the same. What else there is to give a greenish color, the compound microscope must reveal.

HALT 814. 1½ miles from lake. As we go north the conglomerate contains less matrix, being distinctly and simply a conglomerate. In places also it contains more jasper.

HALT 815. ½ mile east of mountain. Strike N. 47° E.

HALT 816. Summit east of mountain. All slate. The last seen of conglomerate is one-fourth mile southeast of here. The dip is vertical. Strike N. 37° E. Mountain visited on the south side bears S. 38° E.

Proceeding W. N. W. the formation becomes conglomeritic again; but it is not a coarse conglomerate.

HALT 817. Making the last ascent. Greenstone apparently well marked, having black specks. It joins on the east beds of conglomerate and slate. In fact it does the same on the northwest, and in spite of appearance, I surmise this is merely an altered sedimentary rock.

HALT 818. At the summit. Highly altered slates and greenstone-like rock.

The following are bearings from the summit:

Mountain visited on the south side (observation probably erroneous).

East Twin mountain...S. 8° E.
West Twin mountain...S. 2° W.
North end of nearest little lake...........................S. 43° E.
From a point twenty rods west of summit:
Mallman's peak...... ....S. 42° W.
East Twin mountain...S. 9° E.

HALT 819. 20 rods west of summit. At this place are laminated, dark-gray, highly silicious argillites. Dip vertical. Strike N. 40° E.

Rock 341. Porphyry-like, but gravelly matrix. Halt 813.
Rock 342. Greenstone conglomerate. Halt 817.
Rock 343. Porphyry pebble in porphyry matrix.

Rock 344. Porphyritic matrix.
Rock 345. Gravelly matrix.
Rock 346. Greenstone (like 342) columnar.

§ 29. GABIMICHIGAMA LAKE.

An irregular lake lying on the four corners of the townships 64 and 65 of ranges 5 and 6. Its main axis trends N. 35° E, and has a length of three miles. The mean breadth is three-fourths of a mile. The water is deep and the shores are bold and even mountainous — especially around the southern half of the lake. The geology is interesting and in some respects peculiar. The middle of the west shore lies upon massive graywacke, but the southern portion reaches into the gabbro region, without doubt a continuation of the range occurring two or three miles south of Ogishke-muncie lake. Titaniferous iron ore is found in abundance.

HALT 820. S. W. ¼, S. E. ¼, S. 26, T. 65-6. The approach to Gabimichigama lake from Ogishke-muncie is through Fox and Agamok lakes, and over the portages around the rapids connecting these small lakes. The whole distance in a straight line is is about two miles; but the portages are little used, and the country is very broken and difficult. The scenery along the water course presents bold features; and one or two wild waterfalls plunge through deep and dim-lighted chasms in the dark silicious argillites.

HALT 820. S. W. ¼, S. E. ¼, S. 26, T. 65-6. Silicious slate. Stream from Gabimichigama passed by a cascade 25 feet high, through a gorge with walls on the east 50 feet high and on the west 40 feet. Strike N. 37° E. Dip vertical. The rock is dark but exceedingly hard; breaks into large cuboidal blocks. It is almost black, and not conglomeritic.

HALT 821. S. W. ¼, S. E. ¼, S. 26, T. 65-6. Outlet of Fox lake. Dark, silicious slate, with contorted lamination. Genera strike N. 78° W. Dip S. 50°.

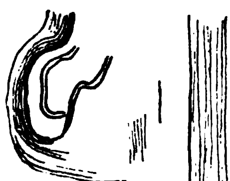

Fig. 58. Folding of schists, Halt 821, Fox Lake

The schists of northern Minnesota have held a persistent strike so far, and with so little contortion, that the presence of these disturbances here indicates the proximity of the dynamic centre.

Fig. 54. Another example of plication at Halt 821, Fox Lake.
a, a, a, bands which bleach white and remain salient. The intervening spaces are darker and depressed.

HALT 822. S. W. ¼, S. W. ¼, S. 25, T. 65-6. Dark silicious slates. Strike N. 87° E. Dip S. 85°.

HALT 823. S. W. ¼, S. W. ¼, S. 25, T. 65-6. Portage out of Fox lake. Slate, very silicious. A few rods back, the rock appears to be erupted — granular-gray.

Rock 347. Erupted rock near Halt 823.

A few rods southeast, the erupted rock suddenly terminates, and silicious slates recur with strike N. 68° W. and dip S. 78° Four rods further southeast are slates uncontorted, having strike N. 82° E. and dip vertical.

Immediately contiguous are laminæ in two courses, which are much convoluted, presenting the appearance of arabesque. The salient laminæ are dark and much like the impressed parts but more cherty.

HALT 824. S. W. ¼, S. W. ¼, S. 25, T. 65-6. Middle of portage to Agamok lake. Silicious slate. Strike N. 82° E. Dip S. 85°.

Rock 348. Flinty slate from Halt 824.

HALT 825. S. W. ¼, S. W. ¼, S. 25, T. 65-6. Across ravine by angle of little lake. Silicious argillite, much broken up.

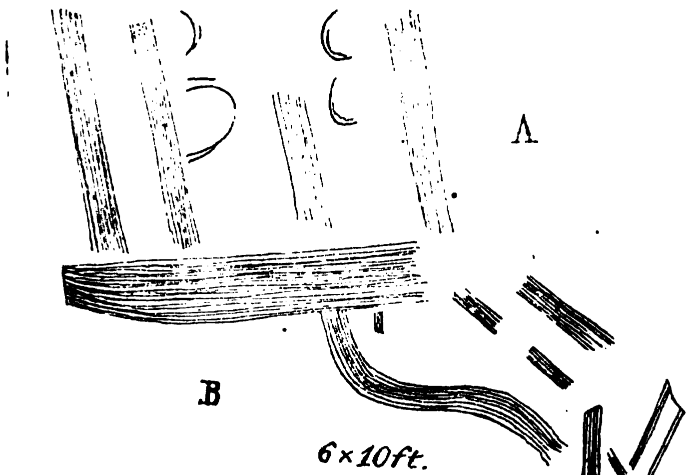

Fig. 55. Broken condition of slates at Halt 825, Agamok Lake.
A, imperfectly bedded. B, not bedded.

Eight rods further southeast, is a band of highly ferruginous slate two feet wide, reminding one of the iron jaspilite further west.

HALT 826. N. W. ¼, N. W. ¼, S. 36, T. 65-6. Near outlet of Agamok lake. Silicious schists, partly dark and argillitic, and partly gray and granular.

HALT 826 *bis.* N. W. ¼, N. W. ¼, S. 36, T. 65-6. Near western termination of Agamok lake. Rock bedded, granular.

HALT 827. Near western constriction of Agamok lake. Rock bedded but gray, granular, with black specks, highly silicious, bedding obscure.

Rock 349. Graywacke-like, as above.

HALT 828. S. E. ¼, N. E. ¼, S. 36, T. 65-6. Narrows of Agamok lake. Same graywacke-like rock as at Halt 827.

HALT 829. S. E. ¼, S. E. ¼, S. 36, T. 65-6. Gabimichigama lake, at outlet. Gray rock looking a little like muscovado gabbro, but it is bedded distinctly.

Rock 350. Muscovado gabbro? — but much like Rock 349.

HALT 830. S. E. ¼, S. E. ¼, S. 30, T. 65-6. Graywacke-like as before. No bedding certainly discernable, but it seems quite confused.

HALT 831. N. E. ¼, N. W. ¼, S. 1, T. 64-6. Graywacke-like, but darker and more crystalline. Not stratified as far as seen, but lies in rough, irregular, horizontal beds in the hill, to the height of forty feet.

Rock 351. Graywacke-like, Halt 831.

HALT 832. S. E. ¼, N. W. ¼, S. 1, T. 64-6. Graywacke-like. Bedding obscure. Strike seems to be N. 56° W. with dip S. 85°. Still, the continuation of same bluff shows only rough horizontal bedding. Fine glistening particles are present.

HALT 833. S. E. ¼, N. W. ¼, S. 1, T. 64-6. Still graywacke-like, but a little darker. This bluff is also rudely bedded horizontally.

HALT 834. S. E. ¼, S. W. ¼, S. 1, T. 64-6. West arm of southern bay of the lake. The rock to six feet above water is a bluish, graywackenitic mass, with augite or hornblende scarcely present. It appears to be essentially sedimentary, with lines of bedding striking N. 68° W, and vertical dip; but the rock on the whole has a very massive aspect.

Rock 352. Massive graywacke. Halt 834.

Above this is an unstratified mass, consisting, with much dark mica, of waxy feldspar so glassy that I am not certain that it is not quartz. This rests on the edges of the first.

Rock 353. Micaceous gabbrolite?— three specimens.

This seems preparatory to gabbro.

HALT 835. N. W. ¼, N. W. ¼, S. 12, T. 64-6. Gabbro of medium texture and apparently some mica scales.

Rock 354. Gabbro — two specimens.

HALT 836. N. E. ¼, N. W. ¼, S. 12, T. 64-6. Entrance to last little arm of southern bay. Gabbro.

Rock 355. Gabbro from Halt 836.

HALT 837. N. E. ¼, N. W. ¼, S. 12, T. 64-6. Opposite Halt 836. Gabbro, a little resinous in color.

HALT 838. Centre S. E. ¼, S. 1, T. 64-6. In the narrows, east side. High cliff, roughly bedded, with beds dipping away from shore eastward at an angle of 45°, suggesting that the bedding seen at Halt 831 and other points, may be a real sedimentary structure. This rock, in part, presents much the appearance of gabbro.

Rock 356. Gabbrolite from Halt 838.

Some of the beds are heavily charged with iron, apparently titaniferous, and have a dark granular aspect. The cliff here rises seventy feet high.

Rock 357. Band of iron-bearing rock.

HALT 839. N. E. ¼, S. E. ¼, S. 1, T. 64-6, Muscovado gabbro, fine, resinous, bedded, with dip eastward 40°.

HALT 840. S. W. ¼, N. W. ¼, S. 6, T. 64-5. A remarkable headland. Some forty feet perpendicular. The whole exterior presents a rusted appearance, and is crumbling away. It seems to be rudely bedded almost horizontally, but with a small eastward dip. The rock is heavy, and seems to be composed largely of carbonate of iron? Apparently there is also considerable hornblende or augite and mica. In crossing the promontory, the sheets of rock outcrop and overlap like successive outflows of molten matter.

Rock 358. Sideritic? rock from Halt 840.

HALT 841. Centre N. W. ¼, S. 6, T. 64-5. Island. Coarse gabbro poured over a huge pile of coarse, angular fragments of muscovado. An interesting observation, for the muscovado is stratified. The interstices among the fragments of it are filled so completely as to demonstrate the original fluid character of the gabbro.

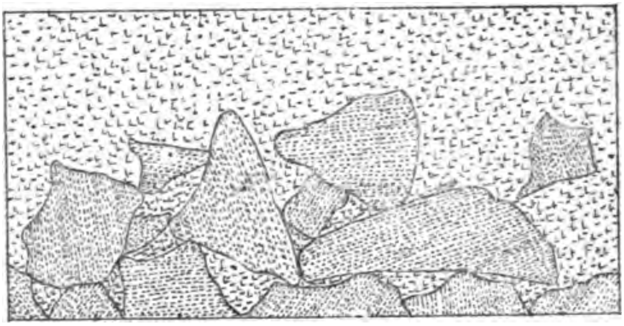

Fig. 56: Gabbro on "muscovado" fragments, Hall 841., Gabimichigama Lake.

Gabbro was seen in a high characteristic outcrop on the extreme southeastern shore beyond the large island, but the rough condition of the water rendered it impracticable to land.

§ 30. SUMMARY OF OBSERVATIONS.

The foregoing is a particularized exposition of observations made within the region indicated. For convenience of cursory readers, I offer here a condensed general statement of the facts.

General Condition of the Rocks. — The region so far as traversed, presents geologically a series of schists flanked on the north and south by massive crystalline rocks. In the western part, these are gneissic on both sides. In the eastern part, the schists extend north beyond the limits of the field, and on the south, the gneissic rocks are replaced by gabbro and greenstone. The schists and the bedded crystallines stand in a nearly vertical attitude, and have a strike which is east-northeast in the western part of the region, and northeast or north-northeast, in the eastern part. The strike is remarkably persistent and uniform. Seldom are flexures in the alignment noticed until we reach the Ogishke-muncie and Gabimichigama. A similar statement may be made of the dip. It oscillates from eighty degrees northward to eighty degrees southward. Very rarely do we find the dip varying over ten degrees from the vertical. What variations exist are not prevailingly northward nor southward. It appears that the normal attitude is vertical, and it is not at present possible to state which deviation from this is the result of inversion.

Nature of the Schists. — Mineralogically, the schists embrace

sericitic schist, chlorite schist, argillites, graywacke schist, mica schist and hornblende schist. Very commonly the mineral character is mixed — the chloritic constituent being present in sericitic schists and argillites, and the argillitic character often remaining in sericitic schists. Not unfrequently, the sericitic schists have to be qualified as both chloritic and argillitic. The mica and hornblende schists are generally exempt from chloritic intermixture. though, as will be stated, many gneissic rocks abound in a chloritic constituent — probably the result of alteration.

In the western part of the district. sericitic schists predominate; and they are mostly confined to the western and middle parts — that is, to the region of Vermilion, Eagle Nest, Long, Fall, Newfound and Moose lakes. In the eastern part of the district, argillites predominate, and they are mostly dark colored and widely silicious. They prevail especially in the regions of Knife, Pseudo-messer, and Sucker lakes, but argillitic schists often appear, more or less mixed, through the whole extent of the region, and a small area of sericitic schists was found on the shore of Kekekabic lake.

Well-developed mica and hornblende schists are not very common, but they exist along the belt of approximation between the crystallines and the earthy schists. This will be further explained.

In structure the earthy schists present every conceivable variation. To a large extent they are compact, hard and not readily cleavable, though the principal foliation almost always coincides with the planes of sedimentation. From the hard and unfissile state they graduate to characteristic shales, and thence to the most thinly laminated phyllites.

Graywacke.— A very conspicuous feature of the schist belt is the frequent and often abrupt transition from a pronounced slaty structure to a massive structure, in which the bedding planes are obscure, and in many cases scarcely discoverable. These massive conditions present the ordinary external appearance of diabase, and sometimes of dolerite; and it requires many observations to convince one's self that none of these are truly eruptive. At times these masses are found cut up by joints into cuneiform cuboids, ringing and flinty, precisely like rocks of eruptive origin; and if one were to restrict his observations to a few such occurrences, he would feel persuaded that large portions of the region are occupied by true dikes of enormous extent. But

with surprising abruptness these rock-masses are seen assuming a more earthy character and losing their eruptive features. Close by, the lines of an ancient stratification come into view, and these always conform in position to the rule of the region. The rock may now be seen more distinctly to contain an important quartzose constituent. This is sometimes in fine, almost indefinable grains and sometimes a silicious groundmass. A different condition of the rock contains, with more or less quartz, a considerable feldspar — mostly orthoclase, but partly triclinic. This appears sometimes in distinguishable grains imbedded in the silicious or silico argillaceous groundmass, and sometimes as a feldspathic groundmass holding obscure grains of quartz. Not unfrequently the groundmass appears to be a real petrosilex. In all cases the rock possesses great hardness and toughness. These are the macroscopic characters of a range of rocks which I have called graywacke. Many times an intermediate condition is found — the sericitic or argillitic or chloritic character appearing progressively and increasingly in the sub-massive rock. I have then described the rock as graywackenitic.

Though this group of rock-varities does not present the typical aspect of graywacke, especially in its predominantly massive conditions, it seems to approach nearest that rock as described by recent writers of authority.

Arrangement of the Schists.—In the western portion of the region, the central part of the schist-belt is occupied by strata predominantly sericitic. With these are associated hæmatitic, magnetitic and ferruginous jaspilitic beds and bands. The sericitic belt passes from the southeastern shores of Vermilion lake. It covers the greater part of T. 64-14, including Eagle Nest, Gem, Sand, Nameless and Mud lakes. It is supposed to cover the northern part, at least, of T. 63-12. It embraces the southeastern corner of T. 63-13. In T. 63-12 it embraces all of Long lake except the northwestern bay, and covers, apparently, all the southeastern part of the town. The greater part of Fall lake in T. 63-11, is in sericitic schists, and they extend south to include part of the northern shore of Garden lake, and north far enough to embrace Newton lake in T. 64.11. In T. 64-10, the sericitic schists have been seen only on Urn lake, but probably they occupy most of the southern half of the township, They extend in a broad sweep diagonally through T. 64-9, including Moose and Newfound lakes. Entering T. 64-8, in a broad belt on the west side, they cover the region of En-

sign lake, and in the eastern part of the township wedge out. Further east sericitic schists are exceptional.

Considering more precisely the distribution of the various species of schists, it may be said, in a general way, that the more chloritic schists lie on the north and south of the central line of the sericitic schists, forming two broken belts; but they often occur in the midst of the sericitic belt, and in parts of the region they are comparatively wanting. Generally speaking, the argillites are somewhat clearly restricted to belts still more removed from the main axis of the sericitic schists. They under go a large development toward the east and in large part usurp the place of the sericitic schists; while westward the latter quite frequently retain a character somewhat argillitic.

Still outside of the predominant argillites, both on the north and the south, are those forms of clastic rocks which I have styled graywacke. Wherever a section is made across the sericitic belt, graywacke is pretty certain to be met along the outer border, but there is no regular and continuous belt of it. The schists pass by gradations along the strike, into graywacke, and the latter passes again into schists.

More distinctly limited to marginal belts are the crystalline schists, mica schist, hornblende schist and diorite schist. On the north side the schists are first seen in the northeast corner of the unsurveyed T. 63-14. They occupy most of the south shore and the southern islands of Burntside lake. They probably form a narrow belt through T. 63-12, but they have not been seen. They are scarcely known in range 11. They have a small development through the centre of T 64-10; but east of that their place is beyond the national boundary.

On the south, these schists make a distinct development in T. 63-11, north of Farm and Friday lakes. Further east, their place is between Snowbank and Ensign lakes, but they have not been seen.

It is apparent that the distribution of the earthy schists sustains little correspondence with the planes of bedding. Everywhere the strike of these planes presents a remarkable uniformity and regularity. But when we attempt to trace a bounding line between the sericitic schists and the chloritic, or between the sericitico-chloritic and the argillites, we find it exceedingly irregular, crossing the lines of strike in one direction and the other. A geological map which should delineate the geographical limits of the earthy schists would assign different colors to

strata of the same age. It becomes apparent that the sericitic, chloritic and argillitic schists are only different states of the same formation. It is pretty certain that the graywacke is only another state of the same, though the graywackenitic alteration has most frequently taken place on the outer verge of the belt of earthy schists.

Finally, it must be said that the indications of a genetic connection between graywacke and the mica schists are very noteworthy. A visible gradation from one to the other has been noted in numerous instances. Still, I think the crystalline schists may be assigned to special areas on the geological map.

Nature of the Gneissic Crystallines.—In the regions remote from the neighborhood of the schists, the gneissic crystallines incline to a characteristic granular structure—the mineral individuals appearing to belong to the order of first consolidation. In other regions, they vary to indistinctly granular, to obscurely granular with more or less of a groundmass, and to a rock consisting of a groundmass variegated by ill-defined blotches, sometimes mixed with distinct mica or hornblende. These forms belong chiefly to the order of second consolidation—following the view of Fouqué and Michel-Lévy.

On the south of the main schistic belt, the gneissic crystallines are composed chiefly of quartz. orthoclase and hornblende. At many localities these individuals are beautifully developed, well-defined and of large size. Especially do we find the hornblende individuals large, bright and black. Sometimes instead, the orthoclase gives us a finely porphyritic crystalline. At other points the quartz is almost completely wanting, and a fine hyposyenitic rock prevails. These crystallines were seen especially around the shores of White Iron lake.

On the north side the crystallines are composed chiefly of quartz, orthoclase, mica and hornblende. Around Burntside lake, hornblende is little seen, and the crystalline is a true gneiss. In many cases, the constituents are well-defined, in others, the mica is changed to hydromica. Occasionally, hornblende is seen associated with mica, and in this case the mica is generally biotite and in good condition. Along the shores of Basswood lake, biotite is often associated with hornblende; but in the most northwestern regions visited, hornblende prevails almost exclusively. Very extensively distributed is a crystalline rock composed of orthoclase and chlorite, or orthoclase, quartz and chlorite. It sometimes contains a little hornblende,

and sometimes nenaccanite is present. The chlorite and feldspar are much blended together, without definite lines of contact. The rock is not distinctly described by authors, but I have designated it chlorite gneiss, whether containing quartz or not. It has been seen most frequently along the IVth Arm of Basswood lake, and in the southern part of Kekekabic.

This rock must have a very large development about Lake Superior, for I find many boulders composed of it distributed over southeastern Michigan.

Very often I find the dark mineral almost or quite wanting, and the rock becomes what I have designated a granulite. This condition, however, seems to be merely local and of little significance.

In a few localities, I have been induced to think the feldspathic constituent in the quartzless crystallines was plagioclase. I have therefore quoted diorite as belonging to the same category as the gneissic forms. More frequently, however, diorite, like diabase, has been seen as a dike. Not improbably some of the supposed hornblende, is truly augite; but I have not ventured to announce any augitic crystallines.

Areas of Gneissic Crystallines.— The gneissic crystallines occur in two separated areas. One of these is on the north of the schistic belt and the other on the south. The northern area is first encountered on the islands and along the north shore of Burntside lake. It has been traced along two lines beyond the northern boundary of the township, for a mile, into T. 64-13. It is found continuing along the southern shores of Basswood lake through ranges 11, 10 and 9. Its southern boundary passes into Canada a little north of Carp lake. It continues northwestward along the boundary at least as far as Iron lake.

The southern mass of gneissic crystallines environs the whole of White Iron lake and the greater part of Garden lake, and appears on Kawishiwi river in T. 63-9. What appears to be the same reappears on Snowbank lake — an unplatted and unvisited township intervening (T. 63-10). The formation completely surrounds Snowbank lake. East of Snowbank, gabbro occupies the probable position of the gneisses, but no characteristic gneiss was found overlaid by gabbro. In the southern part of Kekakabic lake is a chloritic gneiss very similar to the chloritic gneiss which borders the northern crystallines in the IVth Arm of Basswood lake. It might be inferred that this chlorite gneiss is succeeded on the south by micaceous and hornblendic gneiss; but

observation is prevented by the occurrence of gabbro. The inference may be drawn that the gabbro lies on gneiss or granite.

Transition from the Schists to the Gneissic Rocks.—I have mentioned the visible graduation from graywacke to what I have sometimes designated "nascent mica schist"—that is, a graywacke in which fine glistening points appear, which lens-inspection shows to be analogous to fine, pale mica. Similarly a gradual passage exists from the crystalline schists to the geneisses. There is nowhere an abrupt passage from one class of rocks to the other. Proceeding from the schistic side the proximity of the geneisses is announced in three ways: First, by increase in frequency of ramifying veins; second, by occurrence of lumps of gneiss or granite in the midst of the schist; third, by the exact interstratification of schists and gneisses.

In a few cases the intersection of the schists by quartzose or granulitic veins has been noticed so excessive that the resultant rock is a mineral mixture of the two classes of constituents. An observation of very frequent occurrence is the warping of sheets of schist about detached fragments of gneiss or granite found imbedded in the schist. Equally common is the interbedding of schists and gneisses. In such cases an exact comformability between the two exists; and it is beyond question that the schists were subjected simultaneously to the same geological action. As we proceed toward the body of crystallines the frequency of the schist beds diminishes. We have a formation at first three-fourths schist and one-fourth gneiss; then half schist; then one-fourth schist; then one-tenth. After the gneiss is well established a bed of schist occurs once in twenty rods. At first these seem to possess indefinite continuity along the strike. Then they are broken off at both extremities. Then we come to gneiss with only an occasional fragment of schist included. Further on the traces of schist disappear, but scarcely in one instance have I found the bedded character of the gneiss wholly obliterated, when I had the opportunity to examine any considerable breadth of the formation. The details of these transitions have been described and illustrated in the notes already given—especially in relation to Burntside and the western portion of Basswood lake. I have seen no such formation as the granite or syenite described in the books. I have still less found schists or gneisses reposing by abrupt transition on masses of granite or syenite. Least of all have I seen any unconformity between the crystalline schists and the gneisses. Nor finally have I been able to detect the least

unconformity between the gneisses and the earthy schists. I speak only of facts existing within the scope of my present studies. It is not at all improbable that further pursuit of the crystallines would show the gneisses as mere border characteristics, as in the Pyreneese, the Malvern hills and other granitic and syenitic regions.

The Ogishke Conglomerate.—The petrographic characters of this conglomerate are fully set forth in the field notes already given. I do not feel certain that this formation occurs as far west as Vermilion lake; but feel wholly persuaded that it lies in the strike of the western schists, and that it results from a local geological action going on while the schists were accumulating. In the region of which Ogishke-muncie lake is the centre, the conglomerate attains an enormous development. It is everywhere an aggregation of varieties of granitic and quartzose boulders imbedded in a finely granular, mostly greenish, groundmass. With these constituents, we find often, varieties of flint, jasper, granulite, porphyry and "greenstone," so-called. The boulders are in general from one to two inches in diameter; but they sometimes attain a diameter from eight to twelve inches. They are all well rounded. The formation is everywhere solid and indestructible; but in some regions, especially on the southwestern shore of Ogishke-mucie, it has been subjected, apparently, to some altering action which has blended the pebbles with the groundmass, rendering them inconspicuous or undiscoverable within limited areas. The whole rock seems reduced to a diabasic condition. But careful search has in every instance disclosed the essentially conglomeritic character of the rock.

Everywhere the courses of boulders are regularly and precisely interbedded with flinty argillites. These are most abundant toward the northern borders of the formation. The southern borders have scarcely been seen; since the formation seems to be overlaid by greenstones and gabbro. The great bulk of the argillite belt previously mentioned passes north of the conglomerate. Some sericitic beds have been discovered within the limits of the conglomerate area. These facts seem to show that the conglomerate belongs in stratigraphical position within the northern border of the sericitic schists and the southern border of the argillites as they appear further west.

Porphyrel.—I use this term to designate a rock which at first appears like a true porphyry. I have already described its

petrographic characters and its mode of occurrence. It attains a large development on the shores of Dike lake and within the basin of Kekekabic lake. But it is not an eruptive rock. On Dike lake one can occasionally see not only the evidences of bedding and conformability with the adjacent formation, but sometimes, in no mistakable manner, the obscure outlines of pebbles originally existing in the formation. Characteristic as it might seem to be, it is only an ancient fragmental formation, which, by secondary action, has altered the chemical and mineralogical arrangements of the constituents, until its aspect has been completely transformed, and its history almost lost.

Porphyries occur also about Vermilion lake. They have a different aspect from those just mentioned, but I feel persuaded they are similarly the results of secondary action, are in beds conformable with the schists, and might also be regarded as porphyrel.

Dikes and Veins.—Ramifying and tortuous veins intersecting the schists are most abundant in the neighborhood of the gneissic masses. They seldom exceed one or two inches in diameter; but are sometimes seen four inches in diameter, and rarely one or two feet or more. Within a distance of a quarter of a mile of the mass, they may be pronounced quite abundant, but they also occur several miles distant. They sometimes pursue the planes of bedding for limited distances, but generally cross them in every direction. In many cases they are extremely convoluted, and some striking examples have been cited. They are mostly filled with quartz, feldspar or granulite. Rarely is calcite present. Mica and hornblende are seldom seen. In some cases the mode of intersection of different veins reveals two or more epochs of vein-making.

Not unfrequently the larger quartz veins contain crystals of yellow pyrites. The most noted instance has been described* from south Eagle Nest lake.

Quite frequently I find epidote the filling of narrow veins; and sometimes these become so frequent as to impart a conspicuous epidotic character to the rock. In a few cases, heulandite, or what appears like it, occurred also in slender veins.

Bodies of isolated rock having a dike-like form are of frequent occurrence. Sometimes these are undoubtedly true dikes, and they seem to consist of diorite, diabase or even of true dolerite. In a single case the dolerite had assumed an amygdaloidal character. This was at Urn lake, Halt 410. In a few cases, the dike is a muscovite granite, as at Halt 91.

Other dikes, so-called, are of a doubtful nature. Assuredly, we find walls of what appears to be foreign rock in the midst of schists — generally sericitic — but they stand conformable with the bedding. They often possess a different color, and a different physical constitution. Their appearance, however, is illusory. If they seem to have properly defined walls, it is only for a short distance. In the near vicinity they blend, on one or both sides, with the country rock. Moreover, when broken, they are found to possess a laminated structure, and this, though sometimes curiously contorted, conforms in general trend, with the strike of the general bedding. They sometimes even reveal traces of a conglomeritic constitution. Examples of such dikes, so-called, are described and figured in the early portion of the preceding notes.

Such are the facts. I do not wish to discuss, in this connection, the real origin of such conditions of the rocks.

It is noteworthy that no alteration in the contiguous formation seems to have been produced by the so-called dikes last mentioned. But in some cases, the dioritic and diabasic dikes have had the customary effects upon the country rock of the vicinity.

Unity of the Entire System.—It is difficult to spend a season on these rocks without acquiring a settled conviction that all the schists, both earthy and crystalline, belong to one structural system. They have one common trend. They possess one common dip. They pass by gradations into each other, both in the direction of the strike and, to a large extent, across it. On petrographic grounds we may discriminate the earthy schists from the crystalline. But even if we did not find the graywacke graduating into mica schist, we should be compelled to say that the two formations were entirely parallel, though belonging to consecutive ages. Nothing but lithological distinction separates them.

Beyond all question, the graywacke belongs in the same system with the earthy schists. Thus then, the whole range of schists is one structural system. I am not maintaining the non-existence of a structural discordance somewhere in the parts of this system. I must state explicitly, however, that I have not discovered it. I have not seen a group of facts suggesting it. I find only a group of facts plainly attesting the unity of the entire system of schists.

The gneisses are not less incontestably bound up with the crystalline schists. Their conformabilities, their intergradations in

constitution and especially in structure, have been pointed out and constitute a body of facts which appear hardly compatible with the doctrine that the gneisses and the schists typify two different geological systems.

Place and Distribution of the Iron Schists.—I inclined at one time to the opinion that the iron ore shists were restricted to particular horizons, and that they extended in ranges somewhat continuous in conformity with the strike of the schists. I have spent considerable time in the attempt to group the various occurrences in one or two ranges. But I have been led to think the doctrine of ranges contains only a partial truth.

I have stated that while the various sorts of schists lie on the whole, in situations parallel with each other, there are also many transitions in the direction of their continuity—the same stratum being at one place argillitic, in another chloritic, and in another sericitic. This sort of relation extends even to the graywacke. Now, whatever theory may prove tenable in reference to the origin of the iron schists, it is a fact of observation that they present in their general features, intimate structural relations with the parallel and embracing schists. While therefore, like the schists, the iron ores exhibit much persistence in the direction of the formational strike, they do not persist without variation or even interruption. Nor do we find all the known deposits actually confined to ranges which can be traced with great persistence. They appear in the midst of the schists sometimes, as a strictly local phenomenon; and no other occurrence is known in the direction of the continuity of the formation.

Nevertheless, it need not be supposed that no geological principle can be employed in the exploration for iron. In the first place, the deposits only exceptionally depart from the belt of sericitic schists—seldom from the central part. In the second place, they may with best prospect be sought along the strike, and especially in the strike of other deposits already known. In the third place, the search seems most hopeful in regions where the sericitic schists have undergone greatest development. These are most widespread in T. 62-14, 13 (south part) and 12 (south part), T. 63-13, 12, 11 and 10, and T. 64-10 and 9.

Gabbro, Gabbroloid, Muscovado and "Greenstone"—These formations are confined to the southeastern portion of the district examined. Gabbro first appears about Illusion and Ima lakes. It walls in Thomas and Fraser lakes, and stretches northeast nearly to Kekekabic. It is generally quite coarse and

quite uniform in texture and composition. It exhibits a tendency to oxidize and disintegrate. In places the amount of iron is very conspicuous. No traces of vertical bedding have been seen in it. It is not conformable with the schists or conglomerates. The only bedding anywhere seen was nearly horizontal, and here it had the irregularity of sheets of successive overflows of molten matter. Only a very partial examination of this formation has been made.

In the vicinity of the gabbro, I often find a somewhat graywackenitic sort of rock which differs from the ordinary graywacke in its waxy color and more granular texture. We have called it muscovado, in consequence of its resemblance to brown sugar: but its true mineral constitution could not be made out. Nor could it be ascertained certainly whether it is a part of the gabbro, or a separate outflow, or a highly metamorphosed schist. Within the district here reported on, the most striking exhibition of it is on the islands of Illusion lake. No bedding could be seen, but the formation, nevertheless, is often equaled by our graywacke in the massiveness of its aspect.

Within the sheet of gabbro I find sometimes a coarsely crystalline rock having much the appearance of gabbro, and seemingly a similar constitution, but it is uniformly finer, and is quite unidentical. I have in some cases denominated it "gabbroloid," but probably it will prove to be essentially gabbro.

The "greenstone" or green rock in the vicinity of Ogishkemuncie lake is not yet understood. On the mountain south of the lake, we find an extensive development of it, and it appears composed entirely of grouped scales of a green chlorite. One would readily decide it to be an eruptive formation. In consonance with such an opinion is the fact that we find on the west side of White Iron lake, a dike filled with the same sort of matter, and indications of similar dikes in other places are noticed.

At the same time I observed on the high hill north of Ogishkemuncie lake conditions of the common formation which closely approach the greenstone of the south side. But these occurrences were indubitably embraced in the conglomerate. Indeed traces of pebbles could still be distinguished, though the whole was almost completely transformed to a homogeneous-looking "greenstone." In fact a similar observation was made on the mountain of the south side. Near the commencement of the occurrence of the greenstone, it was noticed that outlines of pebbles could be faintly traced; and it was at first supposed to be merely

a phase of the conglomerate. Finally, this greenstone is not essentially different from the groundmass of the conglomerate on the southwest shore of Ogishke-muncie, though the latter is incomparably harder.

On the whole, then, I do not feel prepared to state whether the greenstone of the south mountain, or any part of it, belongs to the system of the Ogishke conglomerate, or is wholly possessed of eruptive characteristics.

Thickness of Formations.—The following are distances across the strike of the schists from the gneissic crystallines on the north to the gneissic crystallines on the south:

First section. From the centre of section 22 in Burntside lake S. 26° E. to the centre of section 19, T. 62-11—a distance of 6½ miles. (Section 19 is simply assumed as the probable northern limit of the southern genisses in the direction of the line drawn.)

Second section. From the east end of Burntside lake, N. W. ¼, N. E. ¼, S. 17, T. 63-12, S. 35° E., to vicinity of White Iron lake — a distance of 5.33 miles.

Third section. From the southern extremity of Arm IV, Basswood lake, N. E. cor. S. 28, T. 64-11, S. 29° E., to rapids in Kawishiwi river (Halt 261), S. W. ¼, S. W. ¼, S. 30, T. 63-10 —a distance of 7.18 miles.

Fourth section. From the shore of Basswood lake, S. E. ¼, N. W. ¼, S. 5, T. 64-9, S. 28° E. to west shore of Snowbank lake (Halt 499), in N. W. ¼, S. E. ¼, S. 35, T. 64 9, a distance of six miles.

The proportions of these distances taken up by the crystalline and earthy schists respectively can not be very precisely ascertained, but they may be approximated as follows:

	CRYSTALLINE SCHISTS, NORTH SIDE.	EARTHY SCHISTS.
First section...	.8 mile = 4,224 feet............	5.7 miles = 29,596 feet......
Second section.	.5 mile = 2,640 feet............	4.83 miles = 25,502 feet......
Third section...	.5 mile = 2,640 feet............	6.68 miles = 35,270 feet......
Fourth section..	.5 mile = 2,640 feet............	5.5 miles = 29,040 feet......
Average ...	3,036 feet	29,852 feet

The graywackenitic belt, which is included above in the earthy schists, may be said to have a variable width of about half a mile. In the vicinity of Garden and Farm lakes, the graywacke spreads over at least two miles. But where the graywacke is wider, the sericitic schists are narrower.

If these schists are to be regarded as folded together, the true thickness of the system would be half of the numbers in the above table.

East of range 9 I have not the data for giving the thickness of the schists between the gneisses. Nor do we find the schists extending southward to gneissic crystallines. As already stated, they are terminated, as a surface formation, by the gabbro; and the study of the region has not yet revealed the nature of the rocks underlying the gabbro. The following, however, are some facts respecting the length of the section across the schists in the vicinity of Ogishke-muncie lake.

If from the gabbro at Halt 834, in the southern part of Gabimichigama lake, we draw a line through Campers' island in Ogishke-muncie lake, N. 15° W, it gives us a section across the strike. Then, from the northern border of the gabbro, the distance across the graywacke is approximately 1¼ miles. The next three miles are across the Ogishke Conglomerate, and that is regarded as extending to the mountain visited south of Knife lake. In this neighborhood, the conglomeritic character of the formation has nearly disappeared, and argillite prevails. Beyond this, argillite extends at least four miles. This whole distance is 8¼ miles. But the direction is not at right angles with the strike. Nor is the strike at all uniform throughout that distance. At points within the region it is N. 82° E. (Halt 824). South of Ogishke-muncie lake generally, we find it from 53° to 78° west of north—trusting to the indications of the needle corrected for regional variation. On the the north side of the lake it ranges from N. 22° E. to N. 47° E. It would be idle, therefore, to attempt to calculate from the length of this section and the direction of the strike, what would be the distance in a perpendicular line across the strike. One might estimate in a rough way, that the schists and conglomerates are here six miles thick, of which the Ogishke Conglomerate makes at least 2½ miles.

We have some means for arriving at an estimate of the vast thickness of the gneissic and granitic formations. The second section, produced northwesterly from Halt 643, will nearly strike Halt 723, at the further extremity of Crooked lake, the most remote point from the central axis of the schists which was reached by the present exploration. This is a distance of 17 miles in a straight line. Over the whole distance, traces of the bedding common to the entire system can be seen; and there is evidence that the whole distance should be reckoned as repre-

senting a portion of the proper thickness of that mass of rocky matter which became the gneiss and granite of the region. This gives to the gneissic crystallines an observed thickness of 89,760 feet.

Morphological Phenomena.—I wish to group here first, some of the facts observed in connection with graduations between one rock or mineral and another; and secondly, a few isolated phenomena connected with the modes of occurrence of some geological conditions. These phenomena I speak of simply as facts without any reference to their origin.

As to gradations from rock to rock, I wish chiefly to recapitulate what has been said.

1. From sericitic schist to argillite. All intervening conditions as to color, seritization, solidification and induration may be noted. This transition is of course most frequent between buff and dark argillites.

2. Between sericitic schist—especially the argillitic varieties—and chloritic schist. All intervening conditions occur. The progress ends in a schist which is eminently and characteristically a chlorite schist. But beyond this is a chlorite rock so profoundly altered that even the schistic structure is disguised. The rock is a ragged mass of irregular chunks compacted together. Seen especially at the falls of Fall river. It is less advanced on the shore and islands west of the falls in Fall lake. Compare Halt 529.

3. Between graywacke and sericitic schist. The passage is often observed along the line of strike, but more frequently across it. Often a stratum which is obstinate graywacke at one point is a slaty rock within a few feet.

4. Between graywacke and chloritic graywacke. As in the chloritic modifications of sericitic schist, so those of graywacke proceed until the rock is almost a compact chlorite, but possessing all the hardness of the primitive graywacke.

5. Between graywacke and hornfels. I have not applied this name to the highly indurated condition of graywacke of which I have already spoken. Hornfels is described as a contact result, especially contact of fine graywacke with granite, as in the Harz, but many examples of highly indurated graywacke deserved to be recognized as hornfels, although generally quite remote from granite. The transitions are very often noticed.

6. Between graywacke and "nascent mica schist." A transition observed in numberless instances. Within a few rods, in

most cases, a "nascent" micaschist discloses itself with fully developed mica. See Halts 522, 527, 528. The passage directly to mica schist is seen at Halts 72, 73 and 74.

7. Between biotite schist and hornblende schist. The passage is essentially one from biotite to hornblende, generally diallage. At first some fine hornblende individuals appear among the fine biotite scales. Occasionally an individual is seen which is biotite on one side and hornblende on the other. At Halt 233 the transition follows the strike and also crosses it.

8. Between muscovite schist and sericitic schist. The muscovite scales grow finer, thinner and whiter at each step. An example at Halt 69. See also Halts 329, 334, 554.

9. Between conglomerate and argillite. An entirely usual passage, resulting simply from the diminution and cessation of pebbles. At Halt 114 the weathering of schists develops a puddingstone structure.

10. Between conglomerate and sericitic schist. See the description at Halt 315. Compare also the conglomerate of Stuntz island in Vermilion lake. See also Halt 467.

11. Between conglomerate and diabasic rock. Both by augmentation of groundmass and by alteration, both of pebbles and groundmass. At the end of the series the pebbles are scarcely discernible, and the whole formation is strongly diabasic. Seen in Ogishke-muncie lake on the western and southwestern shores.

12. Between conglomerate and a "greenstone." The outlines of the pebbles can occasionally be traced. On the mountain south of Ogishke-muncie, and also the one on the north.

13. Between conglomerate and porphyrel. Porphyry in which outlines of pebbles can be traced, and also the rudiments of bedding. Occurs at several points in Zeta and Dike lakes, and in the central part of Kekekabic.

14. Between diorite and sericitic schist. At Halt 116, a fine compact diorite (supposed) weathers to the aspect of a sericitic schist.

Among other phenomena may be mentioned the following:

1. Felsitic veins split by quartzose veins. Halt 91.

2. Structure lines in dikes and veins conformable with bedding of the formation. Seen in a granite dike running with the stratification at Halt 91. Seen in sericitic vein-forms at Halt 56. Compare also Halt 3 and dike-forms at Halt 334.

3. Structure lines in veins not conformable with the bedding of

the formation. At Halt 54 are sericitic veins which possess intersecting lines of structure.

4. Dikes and veins with schistose or slaty structure. At Halt 104, veins of micaceous and hornblendic character occur. The matter appears derived from schists. At Halt 111 is a dike-like form consisting of hydromica schist. Develops conspicuous fibres on weathering. A similar phenomenon at Halt 113, but conformable with the bedding of the formation. A similar one at Halt 565.

5. Relation of crystal axes to planes of bedding. Axes seen coincident in numberless cases. Axes seen transverse in many cases, as at Halt 122, where hornblende crystals cross sericitic schist.

6. Relation of crystal axes to walls of veins. Both attitudes are illustrated at Halt 233.

7. Bedding of unsedimentary rocks. Granite extensively, on Basswood lake. Gabbro on large island in Gabimichigama lake. See Halt 840.

8. Quartz grains overgrown by feldspar. Halt 411.

Drift.—A thin sheet of drift is present in most parts of the region, but it is difficult to discriminate between superficial deposits of such character and those which result from simple surface destruction of the rocks. While we find a large abundance of transported and characteristically rounded rock fragments along the lake shores and through the interior, it is a striking fact that along many shores we find almost exclusively angular fragments, or those simply bruised by modern lake ice. A region comparatively boulderless includes Snowbank Lake, and, as I am informed, a district southward from there.

Seldom are any very large boulders found. Some boulder-like masses strewn along the Rapids No. 6, in the stream on the boundary (Halt 688), far exceed the average size. In a few cases very large rock fragments were noted, which seemed to be mere fragments of a contiguous formation not far removed from place, rather than true erratics. One of these was found on Stuntz' island in Vermilion lake—a poroditic mass. Another was on an island in Burntside lake, and measured some 18 feet in diameter.

Nothing like extensive morainic deposits was anywhere found.

The direction of the glacial striæ in all parts of the region is about S. 21° W.

That the entire region has undergone a vast amount of denudation is a fact everywhere apparent.

That glacial action has been generally operative and efficient is shown by the smoothings and groovings so generally seen on the exposed rock-surfaces. But too much of the vast denudation must not be attributed to glacial action. The general surface for millions of years was exposed to the oxidating and disintregating influences of the atmosphere, before the epoch of continental glaciation, and a vast volume of comparatively incoherent material was already prepared to be swept away. Still we are reminded again, that no very great volume of drift products has been deposited within the region, and the conclusion must be either that a large portion was transported beyond the limits of the region, or the pre-glacial decay was not as great as might be inferred from the truncation of the salient masses of rock.

Topographic Features.—It is worthy of note that the longer axes of the numerous lakes do not conform with the strike of the rocks nor the direction of the glacial striation. In the western part of the region, within the schistic limits, the general trend of the lake axes is about N. 65° E., and this is not much less eastward than the mean strike of the schists. In the eastern part of the schistic district, however, the lake axes are more eastward, while the schistic lines are more northward. In other words, the trends of the lake axes in the western region conform more with the geological structure and less with the direction of the glacial action. In the eastern part of the region they conform still less with the glacial action, and lie still more across the lines of rock structure.

This, at least, is the conclusion from the indications of the magnetic needle. But I feel much suspicion of these indications in the eastern part of the region, and should prefer that the bearings should be re-examined with the aid of the solar compass. I am not fully prepared to believe that the axes of Kekekabic and Ogishke-muncie, for instance, lie across the rock strike at so great an angle, nor that the strike actually makes so small an angle with the meridian as is shown in my notes.

§ 31. PROVISIONAL INTERPRETATION.

Only details of fact have so far been presented. These were intended to enable each reader to draw his own conclusions as far as can be done from a survey of a part of the field involved in the interpretation. For my part, I am not prepared to enunciate many conclusions except in a tentative way. But some partial conclusions are deemed obvious, and will not be negatived by further studies, and some suggestions may be allowable even while subject to revision.

The Structure of the Region.—Evidently, this extensive region of vertical schists has been subjected to powerful disturbances to place the body of rocky sheets on edge. It was a widely felt disturbance, for the nearly uniform strike and dip have been traced for a hundred miles, and few merely local irregularities have been noticed. Thousands of square miles of surface must have been moved consentaneously. Does the belt of vertical schists present a single series from side to side, or a single close fold with the duplication of a series, such that from a middle line the stratification is the same on both sides, but in inverse order? Or are several folds present, causing more than one duplication of the succession of strata?

If no fold exists, the thickness of the system is the length of the line measured across the strike. If one fold exists, the thickness of the system is half the length of that line. If n folds exist, then the thickness of the strata would be shown by the distance across the belt of schists divided by $2n$. In other words if T is the thickness of the formation, d, the distance measured across the strike, and n the number of folds, then in the equation, $T=\frac{d}{2n}$, if we substitute 1, 2 and $\frac{1}{2}$ successively for n, we get $T=\frac{1}{2}d$, $T=\frac{1}{4}d$ and $T=d$.

Now, I think no geologist could cross the belt of schists many times without feeling convinced that the existence of several folds is an impossibility. I feel myself confident that no such recurrences of similar strata are observed as the existence of more than one fold would necessitate. On this question it seems to me that nothing more is to be said. I think a multiplicity of folds could not conceal their existence during a three months' investigation. This is one of the points which I shall set down as settled by the study of only a portion of the entire region.

Do we recognize then, the existence of a single fold? I

believe we do, and the following facts appear to demonstrate its existence:

1. In the greater part of the region examined there exists on the north an extensive development of gneissic crystallines, which grow less schistose as we proceed northward, and may reasonably be expected to pass into a strictly non-schistose state. This mass, whether gneissic or granitic, I will call the northern crystallines. On the south we find a similar mass which I will call the southern crystallines. Here, then, are two extended regions of upheaval. They stretch along either side of the schistic belt. They are adequate to have lifted and brought to a vertical attitude on each side the long body of schists which have been thus moved. There is no other crystalline mass in any such relation to the schists as to give plausibility to the suggestion that the schists had been disturbed by it. The very situation then is one which gives antecedent probability of the existence of a single fold rather than more.

2. Let us examine the succession of strata standing between the northern and southern crystallines. If we take the interval between the gneiss of Burntside lake and the syenite gneiss of White Iron lake, we find on the north side that the beds standing in contact with the crystallines are mica schist. On the south side the beds standing in contact or continuity with the syenite are also mica schist, as seen at Halts 223, 233, 230 and many other localities.

Then next the mica schists of the north we find some hydromicaceous and graywackenitic schists; on the south, next the mica schists, is a broad belt of graywackenitic schists covering most of Garden lake, and often approaching the hornfels condition. Further east and west similar schists follow the mica schists.

Between the belts of graywacke lies the great body of earthy schists. Still, as before said, the chloritic and argillitic tend rather to the outer border of the belt, while along the middle the schists are predominantly sericitic. Here, also, are the hæmatite deposits. If the ores do not occupy the very highest stratigraphical position there would be two iron belts outcropping. I am not yet satisfied that this state of things exists. I can only say at present that the ores occupy the middle zone coincidently with the sericitic schists.

If the strata are recurrent in inverse order on opposite sides of the central axis, there must exist under ground a continuity between the mica schist of the north and the mica schist of the

south; between graywacke of the north and south, the earthy schists are simply folded together, and the crystallines of the north pass down and under all and reappear in the crystallines of the south. The situation would then be represented by the following diagram:

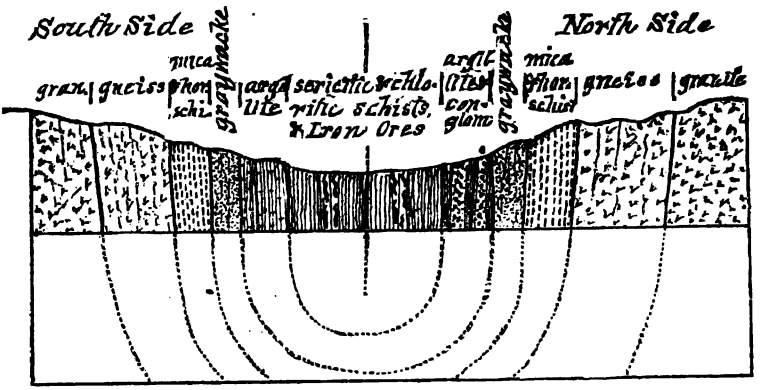

Fig. 57 Theoretical folding of the Vermilion series of schists.

a, *a*, Earthy schists. *b*, *b*, Graywacke. *c*, *c*, Mica schist. C. C. Crystallines.

From this showing, the true thickness of the bedded rocks of the region would be as follows:

First section,	Crystalline schists,	2,112	feet.	Earthy schists,	14,798.	Total,	16,910
Second section,	" "	1,320	"	" "	12,751	"	14,071
Third section,	" "	1,320	"	" "	17,635	"	18,955
Fourth section,	" "	1,320	"	" "	14,520	"	15,840
Average,	" "	1,518	"	" "	14,920	"	16,444

To this aggregate of schists may be added the observed breadth of gneiss on the north side, making a total thicknes of 106,204 feet.

The schists therefore rest in a basin formed in the general mass of crystallines. They occupy a geological valley. We take no note of the form into which the exposed surface has been carved.

It will be noticed from the details of facts given, that the original bedded accumulation does not end downward with the mica schist. A bedded structure strictly conformable and strictly in continuity with that of the schists continues into the deeper crystallines, rendering them all gneissic to the further limit of the observations. We must endeavor to think all these

bedded rocks again in a horizontal position. We then see the earthy schists at the top, followed down by the graywacke and the mica schists, and these still underlaid by intercalations of schists and gneisses, and at the deepest horizon reached, passing apparently into a true granitic rock mass.

This is the character which the succession would have if all were restored to the condition of horizontality. But it is not necessary to conceive that horizontality was retained until each of the series of rocks had attained the petrographic state in which we now observe it.

2. *The Geological History of the Region.*—I am led to think that we may trace in the petrographic and structural phenomena of the region the records of two periods of geological activity—a period of sedimentation and a period of alteration. I conceive the whole mass of rocks brought under consideration to have existed originally as sediments. I express the opinion as an inference from the facts observed within the region, not in conformity with any general theory of primitive terrestrial conditions. Nor do I consider the geognostic causes which so changed the conditions as to introduce heat and metamorphism where aqueous conditions had long prevailed. The rocks—all the rocks—present to me the aspect of sediments more or less altered. Respecting the succession of beds as far down as the graywacke, no difference of opinion will probably be entertained. No one could reasonably exclude the graywacke from the sedimentary series—massive and semi-crystalline as it sometimes appears. It stands in too close relations with the argillites, and affords in itself too many features of stratification to permit the question to remain.

It is but a step further to discover the evidence of the sedimentary origin of the crystalline schists. Their stratification is no less positive than that of the graywacke and the earthy schists. It is scarcely more obscure than that of the graywacke. To assign a sedimentary cause for the structure of the graywacke and seek for another—an antipodal cause, for the similar and parallel structure of the mica schists is to reject an explanation which is probable and adequate, and invent one which is purely hypothetical, and implies a system of coincidences with the structure of the earthy schists which it seems to me is infinitely improbable. I can understand that igneous fluidity may be capable of disposing matter in parallel sheets, but even if it could produce sheets of as great regularity in position and thickness

as the processes of aqueous sedimentation, I do not feel driven to appeal to such a cause of bedding in the crystalline schists and recognize a sedimentary cause in the contiguous and conformable graywacke and earthy schists.

Similar reasoning leads me to trace sedimentary causes through the entire breadth of the gneisses. If originally sedimentary, these have indeed been so altered as to obscure progressively the traces of their ancient condition. If, at the extreme of the series, there be rocks without a trace of sedimenary action remaining, I am willing to believe it has been simply obliterated. The continuity of the succession is too manifest to permit me to think the gneisses experienced an origin totally different in its nature from that of the granites into which they graduate and to which they are inseparably welded.

In what form the original sediments of the gneisses at first existed, I will presently inquire more particularly. The graywackes which still retain something of the sedimentary condition, exhibit evidences of accumulation under circumstances similar to those of later formations. The Ogishke Conglomerate and the argillites present no features of sedimentation in any respect exceptional. It is a fact of much interest that the conglomerate has preserved examples of so many species of granitic and silicious rocks. We might pause a moment to inquire into the conditions of this pebble accumulation. Evidently there were already in existence consolidated masses which had acquired the condition of granite. Somewhere stretched established shores whose slow degradation afforded the materials of this conglomerate. Violence there must have been to disrupt the rocky masses. Violence there must have been to impart such movement to the waters as would cause the attrition and wastage denoted by the thoroughly rounded forms of the pebbles and boulders.

But that ancient granite was not the granite immediately underlying, and which we have studied in the progress of this work. The underlying granite was not yet uplifted. The gathering beds of pebbles were still lying horizontal, and no great disturbance had been felt by any part of the system of formations which we have investigated and have felt disposed to pronounce a unit in its history. This inference is confirmed by the character of the conglomerate constituents. We find there two or three varieties of granite differing from any discovered in the formations of this system. We find flints and jaspers which, as

far as we have explored, could not be afforded by any part of this system. We find nothing which indisputably could have been derived from any member of the system — the Vermilion system, ranging from the granites to the earthy schists. Those older rocks whose destruction afforded material for the building up of the Vermilion system belonged to an earlier age and were parts of an older system. Whether either was what geologists have styled the Huronian system or the Laurentian system, or whether they present us the two systems, or some other systems, the observations of this exploration do not enable us to decide. It yet remains to see one or both of these systems in continuity with, or in some intelligible relation to, some identifiable body of rocks. Of this, however, I feel authorized to testify — the range of rocks lying within the field of my explorations in Minnesota represents but *one system*. I can not, so far, discern any grounds for assigning different parts to different great systems.

There was next a period of disturbance and alteration. The principal features of the alteration I suppose to be as follows: 1. The crystallization of the materials of the gneisses and crystalline schists, and the obscuration of bedding planes. 2. The formation of dikes and veins. 3. The porphyrization of portions of the sediments. 4. The softening and incipient transformation of the mineral and chemical constituents of the conglomerates and some of the earthy schists. 5. The partial sericitization of portions of the argillites. 6. The commencement of the elimination of ferrous oxide from certain minerals in certain formations, and the accumulation of it in distinct regions and specific horizons. 7. The simultaneous disengagement of free silica and its lodgment in the spaces vacated by the progressing transformations, especially within the theatre of ferrous oxide formation.

These changes — physical and chemical — are of such a nature as to evince the action of heat in conjunction with water, and may be referred to as thermal alterations. I recognize, also, another category of changes which seem attributable to the agency of water and oxygen without extraordinary heat, and these I will refer to as athermal. I understand that both thermal and athermal changes have been effected largely through the instrumentality of chemical action. Perhaps it would be more exact to say that chemical action has been the general and the real cause, while the presence of heat, water or air has af-

forded the conditions under which the chemical action has proceeded. Among the athermal results of alteration I would place: 1. The oxidation of portions of the argillites. 2. The extensive chloritization of the earthy schists. 3. The partial decrystallization of some of the injected products. 4. The foliation or fibrous texture of some of the abnormal dikes. 5. The silicification of portions of formations. 6. The probable formation of some of the quartzose veins. 7. The continuance of the accumulation of ferrous and ferric oxides and the consequent augmentation of the iron ore deposits.

As to the method and circumstances of that altering action which inaugurated a new epoch in the history of the sediments of the Vermilion system, we may pause to contemplate a few deductive inferences. We can not, with confidence, determine the cause of the change in the nature of the geologic actions exerted. We perceive, however, that the region had been a long time sea-bottom, and for ages sediments coarse and fine had been accumulating over it. I have shown that the sediments which underwent consolidation into schists have given us a thickness of 16,000 feet of rocks. I have shown that the schists and gneisses, all conformably bedded, constitute a thickness of 106,000 feet. The accumulation of this covering over the bed of the ocean must have exerted an important influence over the relations of the interior and exterior of the earth. If the increase of temperature downward was at that time at the rate of one-fiftieth of a degree Fahrenheit per foot, a temperature of over 2,000° must have existed at the bottom of this bed of sediments, and 1,000° at mid-depth. It is not necessary to assume that just these temperatures existed, to feel convinced that some high temperature had come into existence which must lead to important changes in the beds of sediments.

This thermal condition was not acquired suddenly. The temperatures had been rising progressively during all the ages in which the sedimentation had been in progress. Each horizon of sediments had experienced an ever-increasing intensity of heat. The energy of the action had been progressively augmented. It had been quiet; it grew to become violent.

The heat was not sufficient at the lowest horizon here considered to fuse the mineral substances. But we understand that at a temparature less than 1,000° many minerals are softened or even resolved in the presence of water and alkaline agents. This was the situation in the depths of the sedimentary sheets of

the system. The actions are too familiar to justify a recital of them. For unknown ages, while resting beneath the ocean's waters, they were soaked and heated and boiled incessantly. The busy forces of heat and chemism undid the combinations which had previously existed, and, under new conditions, succeeded in rebuilding the elements in new molecular and mineral aggregates. What was the precise nature of these silent processes it is not my purpose or province to describe. Much has been done by recent investigators to throw light on their nature. Among American laborers in the field, I am glad to acknowledge my indebtedness to Wadsworth, Irving, Van Hise, Becker, Pumpelly, and others.

It was during this epoch, as I conceive, that the most important of those metamorphic actions took place which made these rocks what they are — the deeper-seated being more changed than the newer. At times, the growing energy of the action disturbed wide regions. The movements of the beds — long before consolidated — rent and shattered them in various degrees. As soon as a rent was opened it was filled by some contiguous matter in a molten or in a plastic state. The profoundest fractures pierced most deeply into the crust of the earth, and opened into matter resting in a state of complete fluidity. Or else, opening into a region of matter kept rigid by enormous pressure, brought relief to the pressure and consequent fluidity to the matter. Other fractures reached only to the zones softened by aqueo-igneous action, and received only injections of softened matter which cooled at some later period, retaining upon it the ambiguous traces of both fire and water. Sometimes the fissures in a rock mass were filled with a more softened portion of the rock itself squeezed in and retaining the peculiar dike-like form, while composed of matter undistinguishable from the country rock. Not unfrequently, especially in the shallower zones, the rents received simple aqueous solutions, especially of silica and alkalies, and the fissures became filled with quartz or quartz and feldspar.

In the earlier part of this tumultuous history, there was a period during which gneiss-making and schist-making conditions began to alternate. Then the schist-making conditions began to recur more frequently. Then they persisted for awhile. This was the the most uneasy epoch passed before the final uplift. Not unfrequently alien fragments were deposited on the ocean bed, and the gathering sediments settled around

them. These fragments were thrust up from beneath, or brought by violent movements from some different situation. After the zone of crystalline schists had been buried, the history was marked by comparative quiet, save along the ancient shore whose slow destruction was yielding materials for the Ogishke Conglomerate. Again, however, in the epoch of sericitic schists, there appear to have been renewed disruptions. Fragments, not of gneissic but of quartzose strata, were scattered over portions of the ocean's floor, and around these the sheets of sediments were wrapped, as in other seas and earlier times. Often a field of sediments hardened already, perhaps by silicification, was shattered into numerous fragments, and again the work of silicification recemented them, before they were dispersed.

I desire only to indicate the general tenor of the actions which appear to have taken place even before the final upheavals which brought the beds to a vertical attitude. It would be difficult to ascertain what juncture in the progress of these activities determined a sudden increase in the degree of mechanical violence. It appears probable, however, that the movement of upheaval was rapid. While the strains were accumulating, the body of the sediments remained comparatively unmoved. When the accumulated strains overbalanced the power of resistance, the crisis was sudden and brief. Somewhere on the north, the deep zones of softened sheets were urged upward with such energy as to break through the overlying strata, and to reach, probably, the level of the ocean. Somewhere on the south, the deep zones of softened sheets were simultaneously raised through the rent schists. The mechanical action exerted on the broken schists and gneisses raised their opposite edges along the two entire slopes of the granitic emergences. Pressed from the north and the south simultaneously, by the tendency of the two regions of emergence to unite, the schists suffered a complete folding together. I imagine that their own weight, when raised on edge and narrowed in lateral extent, caused such a subsidence into the deeper regions of the terrestrial crust as to bring their downward continuation within the zone of destructive heat. These schists then have become the mere stubs of their former extension.

Such movements could not take place without the occurrence of many fractures and the injection of many new dikes and veins. I conceive, therefore, that some of the dikes stand in the attitude in which they were originally formed. These are dikes

of the second era. The primitive dikes, however, have been brought to rest on their edges. The direction which represents their ancient downward continuity is that toward the granites.

I am led to think the upheaval signalizes the close of the violent actions which have left their marks upon the system of rocks, while for many ages the scarred and transformed strata have rested in the attitudes in which we have made their acquaintance, those further and less fundamental changes have been in progress, and are still continuing, which I designated as athermal.

With this general outline of the probable history of the region which has been the theatre of a season's study, I leave the more detailed investigations in the nature of the rocks and their molecular histories to future opportunities and to other hands.

3. *Were the Gneisses originally Sedimentary?*—The importance of the subject requires a return to the special question of the gneisses. I am quite aware that an impression prevails that a substantial unconformity exists, or ought to exist, between the gneisses and the crystalline schists. I have been much impressed by the treatment which has been given the question by Mr. Andrew C. Lawson in his very able and well-considered report of the geology of the region of the Lake of the Woods. There is much resemblance between the "Keewatin series" and a part of the Vermilion system. The former, however, is completely isolated from other schists. It lies in a circumscribed basin instead of a long trough, and has been pressed by granite upheavals on all sides. It has, therefore, undergone somewhat different disturbances. But the relations of the crystalline schists and the contiguous gneisses appear to be precisely like their relations in the Vermilion system. It has been the opinion of the earlier geologists, Bigsby, Bell, G. M. Dawson, Selwyn, that the schists and gneisses are conformable. Mr. Lawson, however, argues that no real conformity exists. He recognizes the complete conformity between the bedding planes of the schists and the planes of foliation of the gneisses. But the latter, he maintains, have no necessary or probable dependence on the possible sedimentary planes of a deposit from which the gneiss has been produced. I understand Prof. Irving to place great reliance on the same principle. Mr. Lawson regards the gneisses as having essentially an igneous history. With him, the sheets interbedded with the hornblende schists are dikes, and belong to a later age and a different mode of geological action.

The question is one of such fundamental importance that I quote the passages in which the essence of Mr. Lawson's argument is embodied. He says: "It is highly improbable that the foliation of the gneiss has anything to do with an original sedimentation. * * * * Gneissic foliation is seen to have been developed in a rock which was once in so liquid or viscid a condition as to permit the passage through it of angular blocks of schist to considerable distance from the source from which they were detached. A rock to have been in a state so yielding must necessarily have had all traces of an original sedimentation, if any such existed, obliterated. Furthermore, the existence of a well-marked foliated structure in dikes which have been injected within the schist, both parallel and transverse to its lamination, and which are sometimes traceable in unbroken continuity with the main area of the gneiss, proves conclusively that such foliation was induced in the rock subsequently to its having been soft enough to have undergone injection, and, therefore, to have had any traces of sedimentation destroyed. * * * As a matter of opinion, I incline to the belief that the granitoid gneisses of the Laurentian were never aqueous sediments." Speaking of the interbedded schists and gneisses, of which in one case he enumerates sixteen recurrences of gneiss, he says: "These bands of gneiss, alternating with the schist, are for the most part regular and bed-like in their character, but their true nature as injected sheets or dikes is sufficiently revealed." Speaking of the lack of evidence of sedimentary stratification in the gneiss, he says: "There are some considerations which point to a very distinct historical and natural break between the two series. The most evident of these is the sharp contrast in their lithological characters."

These considerations possess weight, and challenge careful examination. I proceed to summarize briefly the facts which have led me to believe the foliation of the gneisses sustains a relation of dependence on an antecedent sedimentary structure. In making a statement of these, it will appear how I would propose to overcome Mr. Lawson's difficulties.

1. The gneissic foliation follows very exactly the planes of schistic sedimentation. This has been sufficiently shown in the details of the field notes. The fact is admitted by Mr. Lawson, and recognized by many other observers.

2. No reason can be given for supposing subsequent foliation would so closely follow the schistic sedimentation unless a sedi-

mentation had originally existed in the gneisses strictly conformable with that in the schists. This truth the schists themselves illustrate. The schists as truly as the gneisses present us the original sedimentary material transformed by metamorphic action into crystalline forms. As truly as the gneiss, they exhibit a foliated structure. The foliated structure, as everyone knows, follows closely the planes of the original bedding. It is fair to presume that the similar and parallel planes of foliation in the contiguous rocks follow also real sedimentary planes.

The foliated condition, or what is fundamentally the same, often exists in schists less metamorphic. Lawson, speaking of the "clastic agglomerates" refers to "the planes of schistosity which are in the great majority of cases observably identical with those of the bedding."

3. The gneisses and crystalline schists are cognate in composition as well as in structure. Quartz, feldspar and mica or hornblende are the fundamental constituents in both, but with a less conspicuous presence of feldspar in the schists. Lawson says: "It is not uncommon to find in these mica schists a small proportion of feldspar." Bayley, cited by Lawson, states: "Throughout this microcrystalline groundmass are scattered irregular pieces of kaolinized feldspar, porphyritic crystals of the same mineral, with beautiful zonal structure, fresh plagioclase with twinning lamellæ." Some of the hornblende schists are similarly feldspathic. It would hardly seem that the difference in composition between the gneisses and schists is such as to allow the inference that the metamorphic planes conformed to bedding in the schists, and compel us to seek for the explanation of the metamorphic planes of the gneisses by appeal to "a totally different mode of action."

4. If the gneisses possessed a very *different* mineralogical constitution, that would not forbid the reference of their parallel planes of metamorphism to similar causes. Among fossiliferous rocks it is a fundamental principle that contrast of mineral characters in successive strata is no conclusive evidence of difference of epoch.

5. It seems eminently improbable that the gneissic beds intercalated in the schists should be of the nature of dikes. One feels prompted to follow the suggestion with an exclamation point. These gneissic sheets are too numerous, too exact in their parallelism with the schistic beds, and often supported by schistic walls too slender to give countenance to the conception.

Mr. Lawson enumerates in one instance 17 beds of gneiss which alternate with 16 beds of hornblende schist, and one of the beds of gneiss 100 feet thick stands between two beds of schist five and twelve feet thick. It is only conceivable that this alteration was effected before the upheaval; and if so, the schists and gneisses belong to the same epoch — even if the gneissic sheets were overflows of molten matter.

6. Fragments of gneiss very frequently occur in the schists. Hence the gneiss is older than the schists, and could not have been injected into them.

7. The gneissic fragments found in the overlying schist have their planes of foliation in all positions, regardless of the bedding of the schist. If the schistic bedding controlled the foliation of the gneiss immediately below, it would be able to control that of gneiss bodily inclosed.

8. The foliation of the gneisses diminishes as distance from the schists increases — showing that it is inversely as the amount of alteration. As signs of sedimentation diminish, foliation diminishes. The foliation shows some dependence on sedimentation. Its presence is evidence of predisposing sedimentary structure.

9. The adjustment of planes of foliation to foreign fragments, as seen in the wrapping of the folia about masses of schists, reveals the tendency of the foliation to assume relations to external material conditions. It is a coincidence in detail with probable sedimentary arrangements which in the general foliation, we see exemplified, as I think, upon the large scale. The foliation-planes follow the sedimentation-planes in the one case as in the other. Unless planes of deposition act as predisposing conditions on the position and conformation of planes of foliation we should expect the latter to occupy positions out of any relation to objects which might have determined the forms of sedimentation-planes. As a fact, their relation is so close that they follow exactly the lines assumed by the sedimentation features. All these things reveal a connection of dependence between foliation-planes and pre-existing sedimentation-planes.

10. Injected veins do not prove the igneous origin of the whole gneissic mass — nor a completely igneous condition of any part of it — but only a softened state, which, as we know, might be produced at a temperature far below that of igneous fluidity.

11. The foliation often seen in veins — especially those veins before spoken of, in which the vein-matter is closely cognate

with the country rock — may, in many cases, sustain a relation to the earlier sedimentation-planes of the closely contiguous rock with which the vein is in continuity. If so, the planes of foliation might be parallel with the contiguous walls, or at any angle with them. As a fact we find them in some cases parallel and in others inclined to the walls. But if vein-foliation were quite independent of a previous bedded condition of the matter — as undoubtedly is the case in foliated veins of igneous origin — the diverse position of those planes in relation to the vein-walls shows that a contiguous rock-surface is incapable of controlling the position of the foliation-planes; and hence the foliation-planes of the gneiss must have been determined in position by something more than the surfaces to which they have become parallel. We are left again to the most probable supposition, that the conformity with bedding-planes which may have existed is due to some condition in that to which the conformity approaches closest — that is to sedimentation.

12. It is admited that the gneiss, during the period of its metamorphosis, was probably in a pasty condition, though we have no proof that blocks of schist were very far transported in it. Some limited, deeper-seated portions may have approached a state of igneous fluidity. As a general principle, however, the more highly heated portions of matter did not present the conditions of gneiss-making. They afforded diorites and some granites, more especially diabases, norites, gabbros and dolerites. The zone of the gneisses and most of the dolerites lay between the rocks retaining a characteristic sedimentary condition and masses of matter returned from a sedimentary to a molten state, or else — especially in the deeper region — retaining the molten state from a primordial epoch. We are at liberty to assume for portions of the gneisses, any degree of fluidity which observed phenomena seem to indicate; and yet, for the great body of the gneisses, recognize such a history as is indicated most plainly by the general tenor of all the most accessible facts.

13. Some of the difficulties experienced by geologists, especially German geologists and their followers, in admitting a former sedimentary condition of most gneisses and granites arises, probably, from too narrow a conception of geologic history. The period of our gneisses and granites was probably very long subsequent to the intervention of the ocean in producing crustal modifications. Not only were our gneisses and granites once real sediments, as I venture to think, but beneath them were earlier

sediments unknown to us, which became progressively softened and fused, with the progress of later sedimentation. While the earliest crust must necessarily have been in the nature of a fire-formed slag, that has long since disappeared — unless under the deep sea — and the isogeothermal planes of fusing temperature have gradually encroached on the later formed strata, in order to maintain the thickness of the crust at the value required by the conductibility of the materials and the difference between the external and internal temperatures.

14. The discussion of the question whether certain rocks are to be regarded as of igneous or of aqueous origin, has occupied too much attention. There must always, since the descent of the ocean, have been rocks in formation along the zone where fire and water were contending for supremacy. That zone, as I have stated, has gradually ascended, in consequence of the thickening of the crust on its exterior. So far, however, as the general refrigeration of the earth has progressed, that zone has been lowered. Through the zone of conflict, fire and water have both left their traces. In the higher planes, the action of water has been most conspicuous; in the deeper planes, heat has acted most energetically. Chemism has been everywhere present to accomplish what the conditions permitted in the breaking up of old molecular structures and the creation of new ones. Every rock-aspect within the zone of conflict has originated both aqueously and igneously. There has been no exclusive origination by the action of dry heat or by the action of water — save in those wandering dikes, which have brought sometimes, into the disputed zone, or even into the domain, of aqueous activity, the conditions which normally obtain only in the exclusive domain of igneous action. If we could truly picture the state of matter in the deep, water-soaked and centrally-heated zones of crust, we would see the old but genuine sediments softening into a paste, undergoing a powerful digestion, their molecules, loosened from the ancient ties which bound them, all astir with movement in the search for new affinities; new-formed mineral combinations growing into being, and adjusting themselves in the structural frame which the decaying sedimentation-lines arranged for them, undergoing finally, a total transformation, so that no particle of the primitive sediment remains, though the reminiscence of it is visibly built into the design so conspicuous in the plan of foliation which supervenes.

§ 32. ECONOMIC PRODUCTS.

As the survey has been a strictly general one, no special attention has been given to economic results. What I have to offer, therefore, is merely collateral.

The mineral resource of chief interest at the present time, and probably the one of chief importance, is iron. I have said all that is necessary at present regarding the geological position of the iron ores, their mode of occurrence and the principles of search. Further and more special treatment will be left to other hands. I propose simply to enumerate here the localities at which I have myself observed indications of iron ore, and also those of which I have learned by report. The following localities show my own observations arranged according to halts: In the second column are the localities known from information:

4.	Sec. 20, T. 62-15.		Sec. 8, T. 62-14.
23.	Sec. 13, T. 62-14.		Sec. 4, T. 62-14.
26.	Sec. 14, T. 62-14.		Sec. 20, T. 62-14.
27.	Sec. 15, T. 62-14.		Sec. 21, T. 62-14.
29.	Sec. 15, T. 62-14.		Sec. 22, T. 62-14.
39.	Sec. 36, T. 62-14.		Sec. 23, T. 62-14.
60.	Sec. 19, T. 62-14.		Sec. 13, T. 62-14.
61.	Sec. 19, T. 62-14.		Sec. 18, T. 62-12.
63.	Sec. 27, T. 62-15.	Tower Mines.	Sec. 17, T. 62-12.
64.	Sec. 27, T. 62-15.		Sec. 16, T. 62-12.
65.	Sec. 27, T. 62-15.		Sec. 27, T. 63-12.
66.	Sec. 27, T. 62-15.		Sec. 22, T. 63-12.
145.	Sec. 20, T. 63-11.		Sec. 22, T. 63-11.
174.	Sec. 29, T. 63-11.	Silver City.	Sec. 23, T. 63-11.
176.	Sec. 29, T. 63-11.		Sec. 24, T. 63-11.
229.	Sec. 27, T. 63-11.		Sec. 25, T. 63-11.
286.	Sec. 30, T. 63-11.	Eaton & Merrit (originally).	Sec. 13, T. 63-11.
287.	Sec. 30, T. 63-11.		Sec. 8, T. 62-13.
288.	Sec. 30, T. 63-11.		Sec. 5, T. 62-13.
296.	Sec. 18, T. 63-11.		Sec. 4, T. 62-13.

The sericitic and argillitic slates of the region yield roofing materials of excellent quality and of two principal colors. Some of the most favorable localities for quarrying are at Halts 479 and 485. These are both in Moose lake. The former are of a bluish-gray color, and great tables ten feet square are found weathered out and successfully resisting the action of frost and the atmosphere.

Good flagstones of mica schist, silicious and evenly bedded, are found in Farm lake at Halt 228. Similar stones are found on Burntside lake at Halt 82.

Scythe-stones of good smooth, even quality occur at Halt 82, and again at Halt 92, in Burntside lake.

A fine smooth whetstone material is found at Halt 773, at the portage out of Delta lake. It is a silicious slate. A very similar slate is found at Halt 774, at the portage out of Epsilon lake.

A fine architectural stone, capable of a beautiful polish, occurs at the south end of an island in Burntside lake. It is Halt 106, and the rock is a diorite or hyposyenite, with lustrous black hornblende and a pink feldspar. A beautiful syenite suitable for outside constructions occurs at Halt 886. This is of medium grain.

A handsome rock for inside architecture is the chloritic sericitic schist at Halt 566 in Ensign lake. The chloritic constituent is bright green and gives the rock a showy appearance. But, as the rock weathers rusty, it can not be recommended for exposed situations.

No geological improbability exists of the occurrence of ores of silver in some of the quartz veins of the sericitic schists. The pyrites thrown out plentifully in an opening on an island in South Eagle Nest lake might fairly be expected to prove argentiferous or even auriferous. Simply the question of fact remains to be determined.

§ 33. COMPLETION OF THE STUDY.

The field-work remaining within the district here reported on is not extensive. It may be well to examine the north side of Burntside lake from the west end to and through section 16. The two lakes east and southeast of Snowbank lake, one of which is named Disappointment lake, ought to be visited, though I am sure the approach will be difficult. They lie in a region not far from the junction of the southern syenite and the gabbro of Ima lake. Gabimichigama lake requires further study, and Kekekabic, though quite carefully examined, will probably repay a re-examination.

In the wider prosecution of the survey, the field-work should by all means be extended over the region lying east and southeast of Ogiskke-muncie, as far as Lake Superior and Thunder bay.

Before final judgments can be passed on any part of the region, even that here reported on, the whole collection of rocks and minerals should be subjected to careful and competent microscopic examination. Every aid which microscopic research

or chemical analysis can bring should also be summoned into the investigation. All these researches should be carried on in the light of comparative studies in other fields which have become classic in the history of geological science.

If the study of northern Minnesota can be completed in some such manner as here indicated, I believe the result will mark an era of important progress in Archæan geology.

III.

GEOLOGICAL REPORT OF N. H. WINCHELL.

III.

GEOLOGICAL REPORT OF N. H. WINCHELL.

I. THE IRON ORES OF MINNESOTA.

By reference to the geological map which accompanies this report the statements that follow, respecting the distribution, both geographic and geologic, of the iron ores of the northeastern part of the state will be more easily understood. This map extends from the west end of Vermilion lake eastwardly to the extremity of Pigeon point, including a belt of country thirty-six miles wide from north to south, and about one hundred and forty-five miles long from east to west. Within this area are some townships which have not yet been subdivided by the United States, and no plats of their geography can be obtained. These are mainly left blank. This map is designed to express all that is known, at the present time, of the areal distribution of several grand rock-groups, and to serve as a basis for future exploration and study. It must not be interpreted too closely, for it is apparent that between the points at which personal inspection has been made by any members of the survey, are sometimes intervals in which some changes may take place in the geographic boundaries of which we have now no knowledge, and that these are not therefore represented on this map.

The stratigraphic position of the iron ores of the northern part of the state was indicated in 1885,* in a brief statement in the report for that year. Since that time much private exploration has been carried on, and a season's work has been done by the survey in the country where these ores are found. Much more is known concerning the detailed geological relations of these

* Thirteenth annual report, p. 24.

ores and their parent rock-masses than at that time, but nothing has been learned which invalidates the general grouping then given.

There seem to be three horizons in the strata, in northeastern Minnesota, that have attracted attention for their iron-bearing quality, and there are two distinctly different classes of ore. If these be considered in what may be taken for the descending order the titaniferous ores will come first.

The titaniferous ores. The first examination ever made, so far as known, of this ore in Minnesota, and probably the first in the entire northwest, was done by the survey. The samples examined were from the neighborhood of Duluth,* and the metallic iron amounted to something over sixteen per cent, with quite a notable quantity of titanium. At that time some local interest was awakened over the supposed existence of valuable ore deposits within the corporate limits of the city of Duluth. It is sufficient to say that the excitement soon subsided, when it became known that the ore was likely to run low in iron, and that the amount that was known to exist was quite limited. Besides these facts, the presence of a considerable percentage of titanium would have operated disastrously upon the enterprise, had the discovery been pushed far enough to have been worthy of the name.

In the investigations by the survey which were begun in 1878, numerous instances occurred in 1879, '80 and '81, where the titanic nature of these ores, and their relation to the rocks embracing them, were noted. Samples of iron-sand, from the beach of lake Superior, were gathered at Black beach, near Beaver bay (see survey number 126), weathered out from a rock a short distance from the lake shore. This sand, which is so abundant as to give name to the beach, has the following composition, according to Prof. James A. Dodge:†

Silica	65.17
Titanium binoxide	2.48
Phosphorus	traces
Protoxide of iron	2.23
Magnetic oxide of iron	30.06
	99.94
Total metallic iron	23.50

* Fifth annual report, p. 63.

† "The protoxide of iron was computed as united with 2.48 per cent of binoxide of titanium. I compute how much FeO is required to unite with the determined amount of TiO_2 to form $FeO\,TiO_2$; then I compute what remains of the iron as Fe_3O_4.—[*Dodge.*]

The rock from which this sand is derived is one of the well-known forms of the great gabbro range, an igneous rock which nearly everywhere embraces a greater or less amount of this ore as an original ingredient. In the eighth report of progress the following statement is made concerning this ore:

The iron that is common in this rock seems to be always titaniferous. Very rarely any crystalline forms can be discerned. It seems to have formed in crystalline condition later than the plagioclase and pyroxene. It attaches itself to the poles of the magnet, but yields in decomposition *in situ* a white subtranslucent or opaque substance characteristic of menaccanite.

In the report for 1881 is given the geology of the iron ore found at Mayhew (or Iron) lake on Sec. 36, 65-3. In general it is summarized as follows: It is a condition of the trap of the country, and is almost entirely made up of magnetite. The ore is in the igneous rock, varying in quality very much, even passing into rock that can not be styled iron ore. It involves with itself nodules of coarse gabbro containing considerable magnetite. It also embraces isolated pieces of gray quartzyte (apparently) but which in thin section are seen to consist of plagioclase, magnetite and augite; and some dark, crystalline, micaceous nodules. It has an apparent dip toward the south, in beds whose aggregate thickness is at least fifty feet, but may be seventy-five feet, the actual amount being hid by a swamp. It sometimes gives place to a coarse trap of the same kind, which is so large in amount as to constitute the rock of the place, and its connection with the ore can not be seen. It lies on a fine-grained gabbro, with chrysolite, which resembles a fine granular gray quartzyte. There is sometimes an apparent northward dip, at a high angle, but this is due to a deceptive appearance of columns of basalt. The ore, which is in considerable quantity, is of fine quality so far as metallic content is concerned, and is visible in numerous places in the same vicinity.*

"This iron ore constitutes what is locally known as the Mayhew Iron Range, and is found in a belt about a mile wide on both sides of Iron lake, and on the south side of Portage lake, and between Portage and Poplar lakes." An analysis of this ore has been made by the survey, showing the following composition:

*Tenth annual report, p. 80.

Silica	20.90
Alumina	1.75
Lime	traces
Magnesia	2.63
Titanium binoxide	2.23
Phosphorus	none
Protoxide of iron	2.01
Magnetic oxide of iron	70.29
	99.81
Total metallic iron	52.46

This magnetited trap spreads widely towards the southwest from Mayhew lake, and in several places constitutes bold knobs of iron ore rising above the surface several feet and extending several rods.*

Boulders of magnetic iron ore, containing a notable quantity of titanium, are scattered over the country between Grand Marais and Mayhew lake. These were noted first by Mr. E. Le M. Hoare, who made a preliminary survey for a railroad from Grand Marais to Mayhew lake, and who had some analyses made which showed a content of titanium varying from six to thirteen per cent. They were also noted by the writer in 1879 in making a trip across the country from Grand Marias northward.

Since the foregoing facts were ascertained there has been a rapid accumulation of information, much of it still unpublished, which goes to show that the iron location at Duluth and that at Mayhew lake are connected by a continuous rock formation, and that at many other places between those extremes a similar ore has been found. It is always magnetic; it frequently rises in conspicuous outcrop. It is on some of the highest land in that part of the state; it follows the Mesabi range; it is in the gabbro belt, and varies greatly, and often abruptly, in quality, but it exists in enormous quantities.

In the state of New York are titanic iron ores, and they are associated with the "hypersthene rock," of the Adirondacks. This rock in New York has been classed in the Laurentian, but if it be of the same age as the gabbro range of Minnesota, it is

* An analysis reported by Mr. Hause performed by R. S. Robertson, of Pittsburg, Pa., gave the following result:

Silica	2.02
Alumina	2.68
Titanium	12.09
Sesqui-chromium	2.40
Magnetic oxide of iron	80.78
Lime	traces
Phosphoric acid	0.03

very far from being at the bottom of the crystalline rocks, and if it be of the same origin as the gabbro it seems not to be of the nature of metamorphic sedimentary rock.

It should be stated that it is not by any means true that all the magnetic ores of the state belong to the titaniferous class, while it is true that a large proportion of them do. There are some magnetic areas not embraced in the gabbro belt, which have different rock associations, and there is, often, a considerable amount of magnetite disseminated through the hematite at the best known and most valued mines. Such magnetite is not titaniferous, and if found in large amounts it would be very valuable.

There is besides a notable difference in the titantiferous ores. The most conspicuous outcrops of these consist of a coarsely crystalline black magnetic ore, rising boldly above the surrounding country. The rock association is a typical coarse-grained gabbro, consisting of plagioclase, augite and titaniferous magnetite. The ore seems to grade into this rock insensibly in some directions. In this gabbro rock generally but little, if any olivine can be seen, and the rock is fresh, clean and firm under the hammer. The powdered ore is black.

Other outcrops of this ore, or ore associated with the gabbro rocks, are often in lower ground. The rock is highly magnetic and very heavy, and almost the only discernible mineral associated with it is olivine. The aspect is rusty, from the decay of the olivine; the grain is fine and close, so compact that with the unaided eye the separate grains can hardly be distinguished. While this ore is also generally titaniferous, some late analyses made by the survey seem to indicate that there may be very valuable deposits of this olivinitic ore in the gabbro belt that are not affected at all by this impurity. This ore when crushed has a dark powder, but somewhat greenish, due to the powder of the serpentinous material that results from the decay of the olivine. So far as known, this class of ores appertains to the lower part of the gabbro rocks, and hence lies along its northern edge, but it is possibly distributed throughout the gabbro area.

This rock, and the ore associated with it, seem to compare well with the eruptive serpentinous rock and magnetite of the Iron hill mine at Cumberland, Rhode Island, and they probably have the same origin.

A typical titaniferous magnetic iron ore, besides being apt to disturb the needle of the compass, is distinguished by being

black when powdered, and hard to break, and when freshly broken has a coal-black, but lustrous fractured surface somewhat resembling that of anthracite coal, both in its lustre and in the angularity of the fracture.

Non-titaniferous magnetic ores. There are several well-known localities where the quartz-schist embraced in the same formation as the hematite ores, is highly charged with non-titaniferous magnetite. This is found to occur in the neighborhood of the northern line of the gabbro belt, but not in the gabbro formation. Sometimes these magnetic quartz-schists are closely associated with, and apparently overlain by a diabasic rock, in uncomformable super-position, the schist standing nearly vertical, and the diabasic rock lying over the whole somewhat in the manner of an overflowing igneous rock. The same quartz-schist in other places in the same vicinity is apparently changed to a jasperoid siliceous iron ore of the hematite class, allowing the observer to infer that for some reason, perhaps owing to the greater effect of the igneous rock, there was a greater concentration of the accumulating iron oxide so as to produce magnetite instead of hematite. Such non-titaniferous magnetite seems to be that found in T. 63-11 and T. 59 and 60-14. It is comparable to the iron ore found at Black River Falls, in Wisconsin, and at the western end of the Penokee-Gogebic iron range on the south side of lake Superior. This kind of magnetite accompanies the hematites. It is found, apparently, in all places in the same formation and when it exists in favorable situations, and has sufficient percentage of iron, it has unexcelled qualities as a merchantable ore.

A non-titaniferous magnetite is similar in outward characters to the titaniferous, but has a less lustrous black color, and is apt to act more powerfully on the compass needle.

Hematite ores — Historical. The great merchantable ore deposits of the state, and of the northwest, so far as known, are of hematite, although some of the mines at Negaunee and Ishpeming, in the state of Michigan, have supplied large quantities of non-titaniferous magnetite.

The first official information which the state of Minnesota had of the existence of iron ore in the northern part of the state, was furnished by the late state geologist, Henry H. Eames. Although the work of Mr. Eames in the region of Vermilion lake was directed, in the main, toward the discovery of gold and silver in the numerous "veins" and "leads" with which he found the rock of

the region to abound, his report for the year 1865 contains the following concise account of the region in which the Minnesota Iron company has since opened the wonderful mines of the Vermilion range.

THE IRON RANGE OF VERMILION LAKE.

"The iron range of Vermilion lake is on the east end of the lake, on the stream known as Two River, which is about sixty feet wide. There are two parallel ridges, forming the boundary of this stream, and at the mouth, on each side, are extensive tamarack swamps. This range is about one mile in length. It then ceases, and after passing through a swamp another uplift is reached, from two hundred and fifty to three hundred feet high. The iron is exposed at two or three points, between fifty and sixty feet in thickness. At these points it presents quite a mural face, but below it is covered with detritus of the over-capping rock. On this account its exact thickness could not be correctly ascertained. The ore is of the variety known as hematite and white steely iron, and is associated with quartzose jasperoids and serpentine rocks. It generally has a cap-rock of from three to twenty feet thick. A little to the north of this is an exposure of magnetic iron of very good quality, forming a hill parallel with the one described.

"The hematite iron has a reddish appearance from exposure to atmospheric influence; its fracture is massive and granular; color a dark steel gray. The magnetic iron ore is strongly attracted by the magnet and has polarity, is granularly massive, color iron black.

"The timber here is very abundant and good, of the same class as prevails elsewhere in this region."

In the appendix to the same report Mr. Eames gives several assays of iron ore from the Vermilion range, showing a percentage of iron varying from sixty-five to eighty.

In the report for 1866 Mr. Eames makes further mention of these iron ores, saying that they are quite extensive, and exist in large masses both at Vermilion lake and further toward the northeast, as well as toward the southeast. Those toward the northeast, he states, are of hematite, but those toward the southeast are magnetic.

Furthermore, in giving the geology of Pokegama falls, on the upper Mississippi, he mentions the existence of iron ore as one of the rocks in place on the rapids of Prairie river. In the accompanying appendix he gives three analyses of iron ores taken from the rocks at Prairie river, the iron ranging from 51 to 70 per cent.

Soon after this a systematic attempt was made by Mr. George R. Stuntz to develop the Vermilion iron ore. In company with Mr. John Mallmann and a few laborers he erected a cabin on the

lake shore at the east end of what is now known as Stuntz bay,* and spent several months making excavations with drills and powder. He produced a fine showing of good hematite ore, and with great difficulty and fatigue he carried a quantity of it to Duluth. It was doubtless from this exploration that resulted the fine museum samples which were distributed by the Smithsonian Institution, mentioned by Prof. A. H. Chester in his report,† exhibited at the Paris exposition in 1867. Mr. J. Kloos also refers to beautiful specimens of the same seen by him at St. Paul, prior to 1871.

The present survey of the state was begun in 1872, and in the various annual reports of progress are references made to the iron ores of the northern part of the state, the first being in the seventh report (for 1878) in summarizing the observations of the season on the geology of the region. Two analyses are given of ore from the Mesabi range and the ores are compared to those of Scandinavia and Russia, as well as to those of northern Michigan.

"For making steel these ores excel, and iron from the Scandinavian furnaces is imported into England for the manufacture of steel. It is highly probable that these iron deposits will not lie long undeveloped. They are in the midst of hardwood timber sufficient for producing the necessary charcoal and the surrounding country is generally fit for prosperous farming." ‡

In the eighth report are given analyses of two samples of ore from the Mesabi range (survey numbers 438 and 441), these being hematites. The metallic iron was found to vary from fifty-three to sixty per cent. On page 103 is a description of the iron ridges on which subsequently were opened the works of the Minnesota Iron company.

In the ninth report (p. 108) is an account of a visit to the original iron locations in towns 59 and 60 N., R. 14 W., where in 1875 some shallow pits were dug under the direction of Prof A. H. Chester in pursuit of the principal iron mass.

In the tenth report special attention was again directed to the explorations that had been made by non-resident capitalists in the iron region of the northern part of the state, and suggesting that Minnesota capitalists ought to look after this matter, and by concerted action retain within the state as much as possible of the

* The remains of this cabin, largely built of stone, were plainly visible in 1886, when the survey party visited the place.

† Eleventh annual report, p. 155.

‡ Seventh report, p. 28.

profits consequent on the approaching development of these ores. "Eastern iron deposits and eastern furnaces should not be allowed to find it profitable to send their products past our doors when we have every requisite and every facility for producing the same. It would be a thing highly creditable to the regents of the university to be directly instrumental in developing this great industry, and I hope that general attention will be called to its feasibility."*

In the eleventh annual report is published a report from Prof. A. H. Chester, giving important information concerning the geology and the mineralogy of the iron ore deposits of the Mesabi range and of the Vermilion range. This is based on the explorations he made, in 1875 and in 1880, under the management of Mr. Geo. C. Stone, now of the Minnesota Iron company. This report also contains a short statement of views concerning the age of the iron-bearing rocks of Minnesota.

In the thirteenth report is a somewhat extended account of the Vermilion iron ores, and particularly of the developments of the Minnesota Iron company at its various mines, giving the results of many assays and comparisons with the Michigan iron ores; also a discussion of the stratigraphy of the crystalline rocks of the northwest in which these ores are embraced.

The geology of the hematite ores in Minnesota. Near the south shore of Vermilion lake are the mines or openings of the Minnesota Iron company. Since they are closely contiguous, and under one management, sometimes they are classed as one mine, instead of several mines, the workings of one pit directly articulating with the shafting or tunneling of the adjoining pit. These are mostly open mines, though some underground work has been done at several, and particularly at the Breitung pit, and still more will be necessary as the working proceeds.

The country is occupied by a variety of sedimentary and igneous rocks, and by the metamorphic schists that result from changed conditions of the same. In the immediate vicinity of the mines the country rises in the form of two nearly parallel ridges separated from each other about a mile. These ridges, rising about two hundred and fifty feet above Vermilion lake, and about a hundred and twenty-five feet above the surrounding country, are caused by and composed of the iron-bearing strata of the range, and consist of siliceous, reddish jasper, banded with hematite, and of siliceous schists and of greenish magne-

* Tenth annual report, p. 8.

sian schists. The ore is associated with the jasperoid rock, and is closely banded in it, the two being so intimately mixed that the whole belt of jasper rock is considered the ore-rock and is mined as ore. The jasper is seen to change by insensible stages, on the one side to pure hematite, by the addition of more and more of the ferruginous element, and on the other by the withdrawal of the same and the increase of silica, it becomes a white "chalcedonic" quartz, which on disintegration becomes a white granular sandrock, so easily crumbled that it can be crushed in the hand. The grains, however, in thin section do not appear to be rounded by attrition as in ordinary sandrock. There are all conditions of change in this interesting transition, varying both in the color and in the hardness of the rock. The colors vary from scarlet to black, and to white. As there has been a tortuous overlapping and twisting of the formation, these colors run in ribbon-like bands, closely aggregated, but parallel, in very beautiful stripings; and as this rock forms the backbone and the crest of these ridges these parti-colored patches of bare rock are common on the tops of the ridges and gave indication of the valuable nature of the contents of the hills. Four or five miles toward the southeast from these hills is another hill, still higher, known as Chester's peak, composed of similar rocks. There are also smaller areas of the same kind of rock in some subordinate hills, and short parallel ridges that lie between the mines and Vermilion lake, while toward the northeast such rock is known to occur at intervals for a distance of nearly forty miles.

The bedding stands nearly vertical, the dip sometimes varying a little toward south, or more rarely toward the north; but, in a few places, extending sometimes for half a mile or even more, there is so much irregularity in the bedded structure that no dip nor strike can be predicated for the general formation, but there is a congeries of more or less angular masses of rock showing a varying and discordant strike, pressed together so as to make a compact mass, with the edges nearly vertical still.

The most common rock seen in close association with the jasper-hematite ridges is a soft schist which normally is of a light green color, but which in close proximity to the jasper-hematite ridges becomes stained with iron, taking on a darker and darker color of red, until, in contact with the hematite, it is charged with iron to so high a degree that its original characters, both structural and chemical, are almost obliterated. Where it has its normal structure it is finely schistose, the schists running

in a nearly uniform direction, northeastwardly, in coincidence with the general strike of the sedimentary structure, but when it is reddened by the ferruginous rocks, it is not schistose, or is less so, but somewhat massive. It can not be said to be a soft hematite, but its color and grain give it the semblance of a valuable iron ore. Where the jasperoid rocks are not hematitic, however, such contact does not produce this change in these schists. They lie in immediate contact with the jasper rock, their schistose laminations winding about the rounded surfaces and accommodating themselves in their sinuous courses somewhat to the direction of those surfaces, though having a constant tendency to resume their prevailing direction. This greenish schistose rock is probably of igneous origin, and its relations to the jasperoid rocks, filling all their cavities, overlying them unconformably, destitute of sedimentary lamination, holding fragments of transported jasperoid rock of all sizes from that of a pin-head to masses several rods across, not only indicate its later origin but the direction in which it moved in its creeping motion. These transported pieces seem to have been obtained from the jasperoid ridges and carried, locally, toward the north.

This greenish schist, passing into a chlorite schist, and extending many miles over the country toward the east and northeast, shows stages of transition toward the prevailing sericitic schists and the graywackes of the region, most of which exhibit unmistakable evidences of aqueous arrangement in the act of deposition. This interesting fact, which introduces an element of uncertainty as to the extent to which the aqueous characters can be traced, should not be confounded with another interesting fact, or series of facts, viz.: that the jasper rock itself passes into a laminated greenish siliceous sericitic schist showing in its various conditions equally evident proofs of sedimentary arrangement. These schists differ, however, in composition and in structure. The former is schistose by reason of a superinduced structure — the same structure, running in about the same direction always, and pervading all the rocks of the country except those that are too siliceous or too granular, which causes the easy demolition of the rocks and their fissile-slaty cleavage. Sometimes this schistosity is nothing more than a short-fibrous structure, most evident on weathered surfaces, producing an elongation in all the grain of the rock in a uniform direction. This fibrous and schistose structure crosses the sedimentary lamination, at all angles, when the two structures

do not coincide in direction. The latter has, besides this superinduced schistosity, an evident thin lamination, due to a sedimentary arrangement in the act of formation, the laminæ consisting of different materials, or varying proportions of the same materials, and manifested on the weathered surface by stripings of different color-bands. It is a fact that confuses the observer, sometimes, that the verticality of the beds carrying the iron ores and the direction of strike of this structure, are coincident in direction with the fibro-schistose structure of the former schists. The lamination of the thin schists which are a part of the iron-ore formation, and evidently of the same age, may be seen at several of the cuts by the railroad that runs near the mines along the south side of the "north ridge," at Tower. The thin silvery foliated mineral in the sedimentary schists, which are interlaminated with siliceous sheets, is prevailingly some hydromica, but the foliated mineral that gives character to the schists which appear to act like a changed eruptive rock is apparently some chlorite. The former may be correctly styled sericitic schists and the latter chlorite schists. Still this distinction, although a fundamental one, can not be made in all cases, inasmuch as the sericitic schists acquire chlorite from a change in some of the grains of which as a sedimentary rock they are composed.

The jasperoid rock, which constitutes the iron ore, has been designated jaspilyte by Dr. M. E. Wadsworth. It is still a desideratum in the geology of the iron of the Vermilion range to ascertain the stratigraphic relations of this ore in the series of strata that constitute the system. At the mines at Tower it is closely embraced in the windings of the green schist or is interbedded with a reddened sericitic schist, and its actual contact is not known with any other rock. In the west end of the "south ridge" the jaspilyte graduates through gray, fine quartzyte, to a rigid black siliceous slate which stands on edge like argillyte. South of the mines, along the railroad, some interesting cuts show the jaspilyte closely interlaminated with greenish sericitic schist. At this last place the jaspilyte is itself much less ferruginated, and would bear the name of bedded fine-grained quartzyte. In the thicker beds, particularly when they swell out somewhat lenticularly, the red and purple tints appear if the beds are broken. At points further east, as at Garden lake, the ore is associated with a siliceous rock, or quartzyte, and seems to be covered unconformably by a greenish rock, or schist, which is

parallelized provisionally with the greenish schist seen at the mines at Tower. It rises in ridges in a manner similar to the ridges at Tower. The stratigraphic equivalence, however, of the ore deposits at Tower with the ore deposits south of Long and Fall lakes can not be asserted. Indeed there is more reason to infer that they are not strictly equivalent, though they are associated in a group of similar strata and have a genetic relationship.

Origin of the jasperoid hematite of the Vermilion range. The nature and origin of the rock which constitutes the ore has been a prolific subject of investigation and discussion. It has been supposed to have originated as a sediment, in its present condition. It has been pronounced eruptive, and it has been considered the result of chemical deposition, or transformation of sedimentary beds by chemical substitution of iron for some soluble component, or for one that was removable by the known processes of metamorphic change.

Is the jaspilyte of eruptive origin? To the writer there seem to be some structural features that indicate strongly that this question should be answered in the affirmative. The ore has a banding such as igneous rocks have been said to show. It is cross-jointed, in its narrower spurs, and cut into blocks by some cause which has given it a structure that resembles the basaltiform jointage of dikes. It exhibits occasionally offshoots or "feeders," so-called by the miners, which strike away at large angles from the parent mass, these showing some disturbance and unconformable relationship to the inclosing green schist.* But these appearances are, in the opinion of the writer, only pseudo-igneous, and must be explained in consonance with some theory that will also explain very evident signs of sedimentary structure and origin. The evidences of sedimentary origin for the rock, originally, which now is mined as ore, are briefly summarized below. These evidences seem to be incompatible with the theory of the eruptive origin of the ore.

1st. The inter-banding of the jaspilyte (hematite, jasper of various colors, white silica) is exactly that which is seen in sedimentary rocks. The different bands fade into each other across the structure by faint transitional stages. They maintain over long distances a parallel striping such as sedimentary thin lam-

* The igneous features have been set forth fully by Dr. M. E. Wadsworth in a bulletin of the Museum of Comparative Zoology, Cambridge, from examinations made by him at Marquette, Mich. See *Notes on the geology of the iron and copper districts of Lake Superior*. Geol. Series, vol. 1.

inæ do in all fine-grained rocks and clays, but when followed far enough they are seen to taper to points and disappear as their neighbors increase. In its hardened and somewhat carbonaceous state this rock appears rigidly slaty, though still mainly siliceous, and stands on edge much like an argillyte. This slatiness is visible in some places where the tortuosity incident to folding and crushing has not been developed. It is straight and distinct, and is in consequence of the weathering out of some of the softer thin laminæ. It is found north of Tower, near the town, forming some of the conspicuous knobs facing toward the south. These slates are not black, but they are dark-colored, and remind the observer of some of the black slates of the Animikie rocks further east, and were it not for their perpendicular position, and their other relations to the surrounding rock-masses they could be considered their equivalent. This slaty structure is due to a weathered condition of differently constituted bedded materials, and differs from the slaty structure that may be developed in igneous rocks due to their fluidal structure, in that it is straight and rigid instead of undulatory or wavy. Rock No. 893.

2d. The jaspilyte, though frequently, and perhaps most frequently, presenting a sudden and definite transition to the schists, showing a possible igneous origin of one or the other, does not always do so. It is found passing by a series of short alterations into a schist, which, though greenish and easily confounded with the unconformable green schist, is a constituent part of the jaspilyte, or at least of the formation in which the jaspilyte exists. This structure and transition is represented by rock No. 894. It is here accompanied by much pyrite. This is obtained near the Ely mine, where the railroad cuts the formation. In this schist, thus alternating with jaspilyte, there is no sign of "baking," so-called, that is assigned to the red-colored schist at the mines, and the inference is natural and inevitable that the jaspilyte, here seen to be the contact rock on the schist, did not produce the effect of igneous dikes, and that this is the original condition of the mutual co-relations of these rocks.

This interbedding of schist and quartzyte, the latter being somewhat purple, extends along the railroad as far west at least as to the Stone mine where it is again well exposed (see rock samples 919). Here the jaspilyte passes by gradations into the green schist. In the immediate vicinity are jasper nodules indigenous in the midst of the schist, red and purple, some of them

five or ten feet long, appearing like quartzose aggregations in the midst of their native sediments. Toward the south, at some little distance from the point at which this interbedding is visible, the siliceous grains are white, instead of purple, disposed in thin sheets.

At the West Ely mine the open pit shows, on the east wall, a sucession of jaspilyte and schist in beds somewhat like the sketch below, Fig. 1.

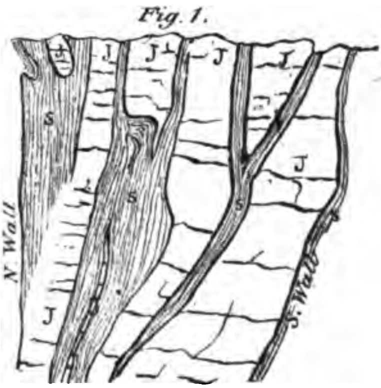

Fig. 1.—*Showing the east face of the open pit at the West Ely mine, and the alternations of schist and jaspilyte.* Width about 50 feet.

At the East Ely mine, next adjoining on the east, the same bedded alternation of schist and jaspilyte is apparent, but owing to the greater development it is brought out more distinctly. The following sketch (Fig. 2) represents the east face of this mine, the observer looking on the edges of the beds. Each one of these beds of jaspilyte has a fine internal lamination which is much contorted. The schists, which are pervaded by a schistose structure when not reddened by iron, and which when reddened are less schistose, and "baked," though soft, do not manifest, so distinctly, a finer internal lamination. The four-inch bed of schist at the left of the sketch runs the whole length of the mine, and even appears on the stripped surface east of the opened pit, running 500 or 600 feet altogether.

At the Stuntz mine the same regular (or irregular) alternation of beds of ore with red shale can be seen, there being visible three schist beds, from six to ten feet thick, dipping N. or N. N. W. about 80°.

That this regular alternation should extend thus for three-fourths of a mile, requires some cause that could open the crust

of the earth in perpendicular sheets, if the jaspilyte be eruptive, and inject equally thin alternating sheets of igneous matter. It is much more like the alternation of sedimentation, followed by upheaval and pressure.

Fig. 2

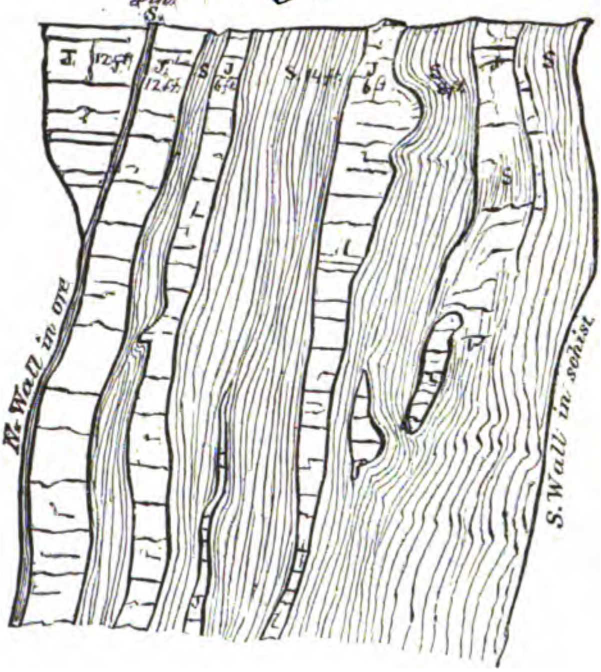

Fig. 2.—*Showing the alternations of schist and jaspilyte at the East Ely minė.* Width about 70 feet.

On the southern slope from the "south ridge" to Tower are some very interesting exhibitions of the relations of the jaspilyte to the schists, some of them showing the minute interstratification of the jaspilyte with the sericitic sedimentary schists, and others exhibiting the manner in which isolated, transported masses of the jaspilyte are surrounded unconformably by a chlorite schist. Of the former the following pen-sketch was made, illustrating a more minute association of the schist and the quartzyte than in figures 1 and 2. The area here represented can be seen to extend, with the strike, a distance of twelve feet, when it fades out gradually by the loss of the siliceous element, and becomes entirely schist. Before this takes place the sili-

ceous bands are interrupted and some nodules and accretions appear in place of the continuous sheets of silica. This quartzyte on the weathered surface is light gray, but on the freshly broken edges shows the jaspilitic colors. The schist is fine and evenly laminated, in its alternations with the quartzyte, and with itself, not being disturbed by coarse sediments, or by faults or contortions. This is one of the most perfect illustrations that has been seen of the manner of transition from the jaspilyte to the schists. Indeed this is not a transition, since nothing but green schists exist on either side of it for a distance of eight or ten feet, as far as the rock is exposed. The diagram shows rather that the jaspilyte is in thin interstratified sheets within the sericitic schists. The sketch does not show, and can not be made to, all the fine interlaminations and gradations between the two, since the schists themselves become arenaceous and gradually lose their green tint, becoming gray, then white, then purple, when broken, and requiring the designation of jaspilyte. The thickest distinct lamina seen here is about one inch, and the thinnest is a mere film and becomes lost in the schist.

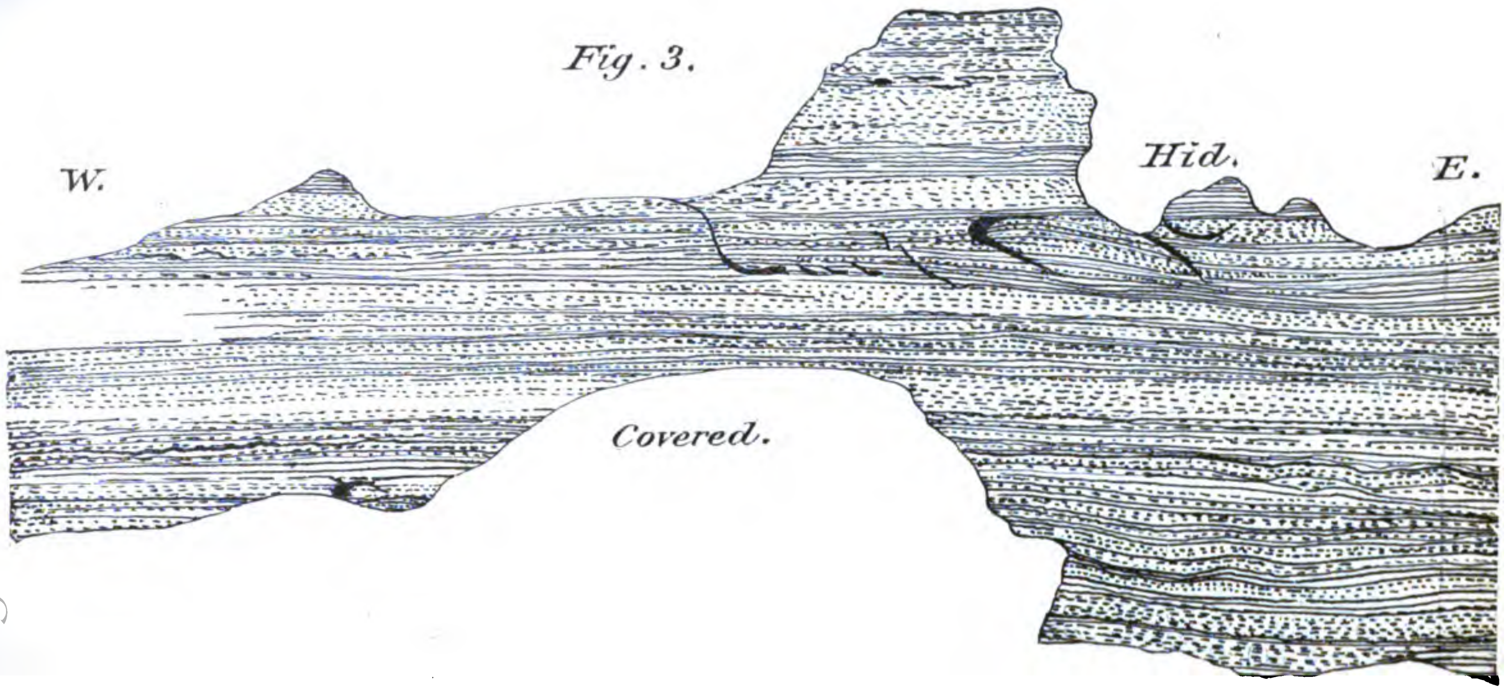

Fig. 3.—*Showing the minute interlamination of jaspilyte in sericitic schist.*

This is a true interstratification, due to sedimentation, since not only does this banding show it, but the schists also show a sedimentary banding. The strike is ten degrees south of west, and the bedding is vertical, or dips at an angle of eighty-nine degrees toward the north. No drawing can do justice to the minute mingling of silica bands with schist bands.

The continuous lines indicate silica sheets and the broken lines indicate the schist. The black irregular patches are intended to show chemically deposited white silica. The distance across the bedding is three and one-half feet, and is exaggerated in respect to the length actually included in the sketch.

Very near this place, about twenty feet north, is a bold exposure of green schists that are supposed to be unconformable on the iron-bearing rocks. These schists embrace irregular masses and arms of jaspilyte, the strike of the prevailing structure being W.40° S., a variation of thirty degrees from the direction of the strike in the schist illustrated by the foregoing figure. The jaspilyte here surrounded by the chlorite schist is represented by rock No. 909.

At a point about fifteen rods east of the place illustrated by figure 3, the siliceous bands do not have the long extension in the direction of the schistose structure which is seen in the figure, but the silica is in fine lumps drawn out in the direction of the schistosity, some of the lumps being not more than a sixteenth of an inch in thickness, or a mere film, and some of them being an inch or two. There is a fine thread-like interlaced mesh of roughness caused by the more enduring silica ingredient standing up on the surface of the weathered schists. In the interstices of the mesh is the schist, some of the areas of the softer rock being inclosed, or nearly inclosed, by the harder, but for the most part prevailing over the harder in one direction, and giving place to more and more of the siliceous ingredient in the other. There is visible here no true sedimentary banding, like that of figure 3, but a dissemination of jasperoid silica through the schist in an irregular manner.* There is no gradation of the schist into the silica, by varying amounts of fine silica mingled in a soft greenish or grayish mud; but the silica, even in the smallest lumps, is pure silica, and the schist does not perceptibly vary in its characters. In one direction, as the silica increases, it forms larger and larger lumps, so that some of them have the characters of jaspilyte, but without the parti-colored

* This point is shown by a photograph made on the spot.— No. 12.

banding. Instead of a banding the colors are in blotches. Still further in the same direction, as the jaspilyte masses increase in size, so as to constitute the most of the rock, they are somewhat banded by alternating colors and sometimes the banding is transverse to the schistose structure. It would seem from these facts that this lumpy silica is due to the dissemination in small pebbles and larger masses, through the molten rock from which the inclosing chlorite schist is supposed to be derived, of the jaspilyte of the iron-bearing rocks; and that chemical and molecular changes incident to the conversion of the massive doleritic rock to the green schist, have given the smaller pebbles a semi-stratified or schistose arrangement in the schist, each mass being elongated in the direction of the prevailing structure; and while the same elongation is stamped on the larger masses, they have not been so affected but that their shapes are better preserved, and their internal structure is still evident.

3d. The schists are not by any means usually *baked* alongside of these jaspilyte belts. This is shown by No. 894, and also by many other illustrations from other points that could be adduced. No. 895 shows a gradual transition between the schists and the jaspilyte, without pyrite, near the same place as No. 894, not from between two jasper belts, but more distant, rather from the general mass of the schist. The contact is most commonly a simple one, with an abrupt transition, or there is a gradual interchange without any appearance of the so-called baking. This gradual transition is most apparent, and most frequent, in other places than along the great jasper belts.

The green schists themselves, at the same railroad cut, seem to become homogeneously arenaceous with the same (rounded?) granular quartz as seen in the jaspilyte—which, if true, seems to require some other explanation besides the theory of incipient disintegration to explain the granular condition of the quartz in the jaspilyte. The theory that the (rounded?) grains were thrown down as a sediment would then be extended rightly over both kinds of rock.

4th. In the non-conformable schists there are what appear to be not only pebbles, but lenticular masses of jaspilyte, or at least of jaspery and chalcedonic quartzyte. These are granular, like all the rest, and easily distinguishable from the secondary or chemically deposited silica. Some are as fine as a pin-head, and do not show much, if any, disturbing effect on the fine laminæ of the schistose structure, and others are somewhat larger, and

larger, and larger, and produce some warping of the laminæ, the warping extending further and further from their surfaces as their size increases. These minute pieces of jaspilyte are of the same character as the larger masses, and must have had the same origin. But they are so numerous that thousands may be embraced in the area of a square foot. They are sometimes distributed amongst the schist rather uniformly, and sometimes they are crowded about some of the larger masses. There is also, occasionally a coarse breccia, with small and large, rounded and angular pieces of the jaspilyte, all embraced in a sparse matrix of green schist, resembling somewhat a conglomerate. The inference is natural, and inevitable, that these jaspilyte pieces could not have been introduced as eruptive matter in the green schists, but must have been coincident in time with the advent of the schist. Their original, first formation, and their source, would still be a matter of further investigation. These fine jaspilyte pebbles are seen in rock Nos. 897 and 889.

5th. The hematite can be seen in some places, where favorable circumstances have conspired to preserve the structural relations, to acquire the finely bedded or laminated, or banded structure seen in the coarser bands of the jaspilyte. This is particularly visible where the hematite is specular—indeed the specular structure is due to the cleavage off of large surfaces of the ore along these lamination planes. In other places this fine striping is seen to fade out both longitudinally and transversely into a massive, hard hematite. This does not show, perhaps, that this banding is not a fluidal structure due to the eruptive nature of the rock, but it shows exactly the structure that would be expected in the rock if it were all of sedimentary origin—at least the jaspilyte—and it seems to indicate that the iron-ingredient is not of the same origin nor date as the siliceous jaspilyte, but of later date, since it partially or wholly obliterates the characteristic fine lamination of the jaspilyte. When it does not totally obliterate it, it accommodates itself to that structure. This is represented by rock 905.

6th. There are places, not common, where the iron ore seems to be a breccia of jaspilyte and "baked clay," or, more likely, a highly ferruginated and hardened clay. There are all stages of ferruginization; some of these breccias not constituting ores, and others affording a lean ore. Generally they are better ores when associated with the large jaspilyte belts, and poor when in small patches. These breccias are supposed to form a constitu-

ent part of the iron-bearing strata, and should not be confounded with those conglomerates made up by the mingling of transported masses of jaspilyte in the unconformable green schists. This ferruginization of fragments of both jasper and clay, in a breccia, seems to show that the iron, as an ore, is not necessarily a part of the jaspilyte, and this idea is borne out by the fact that the ore of the Gogebic range is one that consists largely of a breccia of some soft rock. If then the hematite is not essential to the rock known as jaspilyte, the residue would be almost entirely silica, and it is a novelty to suppose that pure silica could ever have been injected among the rocks of the earth in the form of igneous dikes.

7th. When this silica, which has been styled chalcedonic, interleaved with the hematite and jasper, is weathered, and finally disintegrates, it crumbles into a fine white sand, the grains being of uniform size. It is then friable like the St. Peter sandstone, and could be used for scouring and polishing. If a large piece of such weathered "chalcedonic" silica, carefully selected, be thrown down on the face of the firm jaspilyte, it is crushed with a dull explosive noise, the individual grains of silica flying from the point of impact in all directions, the phenomena being the same as when a slab of soft sandrock is thus thrown down on a hard surface.

On the contrary, when a piece of the chemically deposited silica, taken from some of the veins with which the country rock is everywhere intersected, is thus treated, howmuchsoever it may be weathered, it is either splintered into sharply angular bits of various sizes, or is simply crushed into white powder on some of its corners. In this the white "chalcedonic" silica behaves like the quartzytes at Pipestone and New Ulm. They are also sometimes vitrified superficially and very hard, with the appearance, including the color, of much of the fine quartzyte seen in the jaspilyte, but when disintegrated by the atmosphere they dissolve into a homogeneous white sand. This granulo-friable disintegration is shown by rock numbers 899 and 900.

8th. It is apparent at many places about the Vermilion mines that the great mass of the iron formation (the jaspilyte) is conformable with the schistose structure of the schists that inclose it. It is absolutely conformable with the schists that are, at some points, a little removed from the mines, interstratified with it; and, in a general way it is conformable with the structure of the unconformable schists. On the supposition that the jas-

pilyte be igneous these schists also would have to be considered sedimentary, and this schistosity would have to be taken for the sedimentary structure,* the unconformities, wherever they exist, being due to the fracture of the beds and the introduction of the fluid jaspilyte. Now in order that such a conformability should exist *at the time of accumulation of the sediments*, on any hypothesis, the jaspilyte must have been introduced at the time of such accumulation and while the sediments were yet soft; and that, on the igneous theory, would not account for the angles and arms and "dikes" that Dr. Wadsworth has illustrated at Marquette, running across the sedimentary structure of the schists; and would require that there should be, besides, a marked difference, even now, in the upper and lower surfaces of such inflowing igneous strata, such as we do not see.

9th. If the jaspilyte be supposed to have made its advent after the sediments were hardened there is no other way but to resort to the igneous theory, and then we have many diffculties, viz.:

(*a*) Why should it appear always at the same, or nearly the same, geological horizon? No other admittedly eruptive rock does that.

(*b*) Why should it run substantially conformable to the stratification in all the important localities? No other admittedly eruptive rock does that.

(*c*) Why should the bulk of the whole be a granular silica? There is no other such igneous rock known. If it be said that the granular condition of the silica be due to incipient disintegration, why does the same granular condition prevail at the depth of seventy-five or more feet below the surface, as seems to be the fact in the Vermilion mines? —see rock No. 892.

(*d*) How could the oxides of iron coexist with silica at the temperature needed for fusion without chemical union? No other instance is known.

(*e*.) How could the evenly banded, long-drawn-out, almost never-blending layers seen in the jaspilyte, consisting of nearly the same elements in endless alternation (hematite, jasper, quartzyte) be imagined to have been preserved in their tortuous parallelism during such a flow through open fissures? No other such fluidal structure is known. The real igneous fluidal structure shows a *general parallelism* in the structural lines, in a nearly

* Dr. Wadsworth seems to have so considered it in his paper on the Marquette ores; without, however, vouching for its correctness.

homogeneous rock mass, but the fine bands separate, cross over, blend and mingle in a general flow, at longer or shorter intervals.

(*f.*) How does it happen that the so-called flowage structure is not parallel with the surfaces of the rock walls, in cases where the jaspilyte enters arms or bands or jogs off in the fissured schists? In no case, in the Vermilion mines, has such a parallelism been seen yet; but, either the structure is entirely lost, or it is confused by many fractures, or runs at various angles, even to perpendicularity, to the walls of such a fissure (as at the Stone mine). In other admittedly eruptive rocks the fluidal structure is parallel to the walls of the inclosing rock — at least is parallel to the direction of the flow.

Some remarkable structural phenomena exhibited by the jaspilyte rock have been appealed to as confirmatory of the theory of its eruptive origin, viz.:

1. The jaspilyte structure cuts off the schistose structure, the latter being assumed to be due to sedimentation. But the schistose structure is not due to sedimentation, but to a fibro-schistosity superinduced on a massive rock by alteration and incipient decay.* It has not been seen non-conformable with a true sedimentary structure.

2. Dike-like projections are seen to shoot off from the main jaspilyte mass, forming large angles with the general strike of the jaspilyte.

One remarkable example of this on the south wall of the Stone mine was photographed. It spurs off diagonally toward the S. W. from the main jaspilyte mass. Its width is about two feet, varying to four feet, and it is visible continuously from the top of the mine downward to the first level, about 45 feet, and, passing under the railroad track, is seen again crossing the schists in the same manner, and in the same direction, entering the wall of the next lower level, about 35 feet deeper. This "feeder" is jointed horizontally as well as perpendicularly. It consists of siliceous hematite, and does not show distinctly the banding of jaspilyte.. It is splintery in the direction of its length.

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*One of the most instructive instances of such a change is visible on the S. W. ¼ of sec. 21 and N. W. ¼ of sec. 28, 63–11. Rock samples 1017 to 1023.

The plan of that part of the south wall of this mine which embraces this so-called dike is shown by fig. 4.

Fig. 4.

Place of the Principal Ore Mass.

(Mined out.)

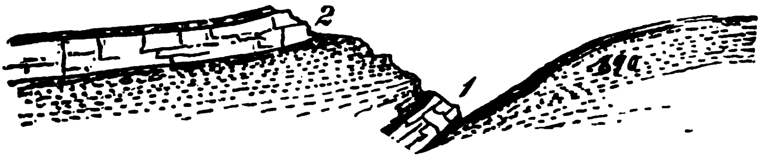


Fig. 4.—*Showing the plan and manner of divergence of the so-called dike, at the Stone mine.*

In this plan the schists are represented by the dotted lines. Nos. 1 and 2 are two beds of ore. No. 1 is the "dike" which is again represented in figure 5, as it appears on the face of the south wall. The schists are charged with iron peroxide, and are entirely destitute of the usual fine schistose structure which pervades them at points remote from the mines. They are coarse-grained, finely jointed with irregular fracture-planes, or are massive and coarsely jointed, similarly to the jointage of the ore. In the close vicinity of the divergent dike they are much confused by close and irregular fissure planes.

Fig. 5.

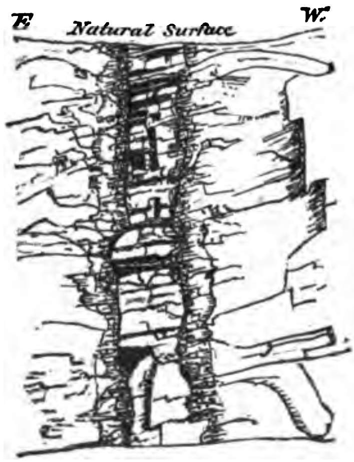


Fig. 5.—*Showing the face of the south wall of the Stone mine where the hematite spur enters it.* The proportionate width is too great. The perpendicular hight is forty-five feet.

No. 2 (Fig. 4) is a bed of ore that was separated from the principal mass of jaspilyte and in the operation of mining it was abandoned for about six rods, but was entered upon again at a short distance to the left of the part included in the plan It seems to have been separated from the main mass of ore by a ferruginous schist-scale, about a foot thick, and its broken-off ends have much the appearance of another "dike" entering the schist. Indeed, it was so interpreted at first, but on further examination the two ends exposed were found to belong to the same "feeder."

These features are not unexplainable on the theory of the sedimentary origin of the rock which now holds the ore. It is only necessary to make examination of the other rocks in the vicinity of Tower to discover that the formation that carries the ore has been greatly fractured and pressed together. The fact that the sedimentary bedding, in nearly all cases, stands now nearly vertical demonstrates that there has been applied to the earth's crust, in this part of the state, an immense lateral pressure. Although the strike of the formation indicates that the greatest pressure was in a direction a little west of north throughout a great area, yet it is evident that the direction varied, and that such variation occasioned fractures, and lateral tilting in directions different from the prevailing one. There are large areas where there must have been exerted a great crushing force at right angles to that which produced the present prevailing direction of strike. This may have been chronologically coincident, or nearly so, with the other, but there is no evidence, so far as known, to demonstrate that this endwise crushing of the strata was occasioned at the same time with the tilting. The tortuous infolding of the jaspilyte upon itself is paralleled in the argillytes and graywackes. The onthrusting of these two rocks upon each other, and the protrusion of elbow-like angles from one into the other, producing dike-like tongues and prolongations, are wonderfully exhibited in many places in sec. 20, T. 62-15, and in some places near Tower. The following sketches made on the spot, as well as some others that were photographed, illustrate the manner in which the graywacke and the argillyte are mixed, mechanically, with each other. These seem to prove that the local transportation of the sediments of one bed transversely across the strike so as to lie unconformably among the laminæ of other beds, is not a feature confined to the jaspilyte and sericitic schist, and does not necessarily indicate that either

of the rocks is of igneous origin; but that such breaking up of the formations was a fact that affected all the beds of that age. Some of these figures bear a resemblance to some that have been given by Dr. Wadsworth to illustrate the relations of the jaspilyte and schist at Marquette.

Masses of coarse graywacke are included in a paste of fine graywacke. Such masses are of various sizes, and are sometimes rounded, and so welded with the matrix that no line of contact can be seen. In other cases they are angular. They are seen also to be placed among the argillitic slates — though more rarely — and the argillitic slates are frequently seen strewn in angular fragments from the size of a goose quill to that of a peck measure, through the coarser graywackes, still retaining the striping of fine sedimentation and showing the feathery fracture that such slates exhibit at their broken ends. These pieces of argillyte lie both transverse to and coincident with the sedimentation of the graywackes.

Sometimes the broken off end of a graywacke stratum will appear to have been thrust diagonally into the sediments of an argillyte stratum, or a splinter from one or the other will extend like a dike, or vein, a few inches, or a foot, into the otherwise homogeneous structure of the entered rock. In some cases, and especially in the case of graywacke, folded loops, a foot or even three feet long, carrying more or less of the adjoining laminæ of the argillyte, protrude boldly across the general structure, particularly across the sedimentary structure, the protruded mass being but a few inches in width.

Fig. 6.

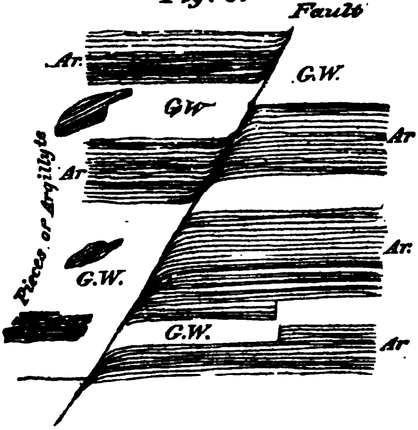


Fig. 6.— *Showing a fault crossing beds of argillyte and graywacke, along which was a contact plane, and a lateral movement so as to warp the beds in opposite directions on the opposite sides; also showing isolated pieces of argillyte in the midst of otherwise uniform graywacke.*

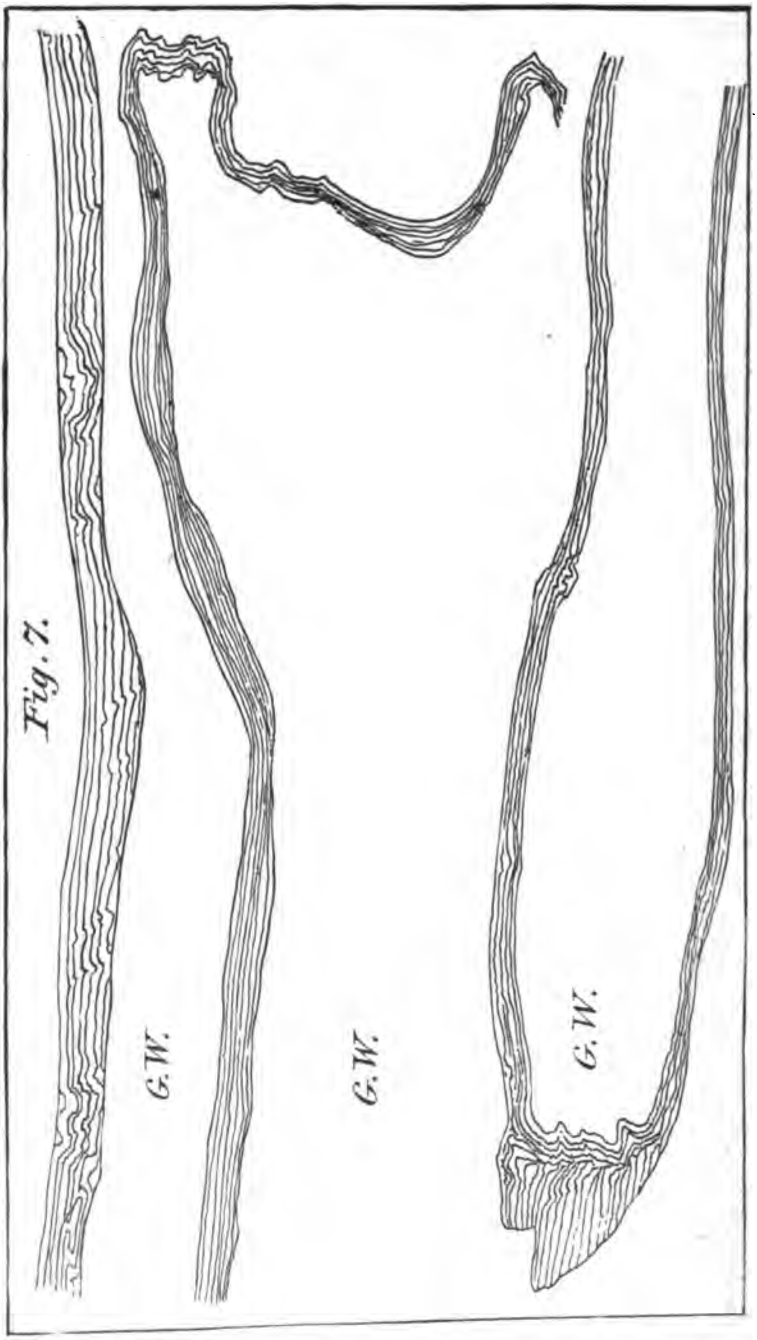


Fig. 7.— *Showing a winding dike of argillitic slate cutting a bedded, but very uniform, graywacke rock.*

On sec. 20, 62-15, the graywacke becomes coarser, with arenaceous grains, and gradually assumes the character of a fine jaspery conglomerate in which the pebbles are arenaceous quartzyte of a somewhat amethystine hue. These conglomerate beds are from an inch to twelve inches in thickness, and alternate regularly with argillyte, following the latter in all its tortuosities. It is twisted back and forth, broken, folded, and "shortened."

In some places it becomes very coarse, and, by the longitudinal shortening it is made to swell out in lenticular, or in very irregular bunches, the fine pebbles being mingled with the coarser ones. The pebbles are from the size of a mustard-seed to peas, and also larger, and the matrix is a green, soft schist which, also, is undistinguishable from argillyte in some of its stages of change. In those places where the aggregation seems to have taken place laterally, perhaps since the first deposition of the beds, the pieces are coarser and the cementing rock is not so commonly and so plainly the soft green schist mentioned, but is siliceous. Most of the pebbles are jasperoid rock, but occasionally there is one of different rock. These latter are found in the coarser portions.

In other places, in the graywacke, are seen some pebbles, two or three inches in their longer diameter, of the same kind of rock as the pebbles in the conglomerate of Stuntz island, mingled with these fine jasper conglomerate bands. Sometimes these pebbles, much finer, make really the most of the fine conglomerate. Such conglomerate bands, however, are narrow, and not common here.

Fig. 8.

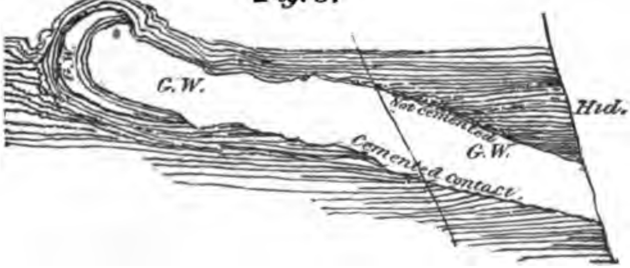
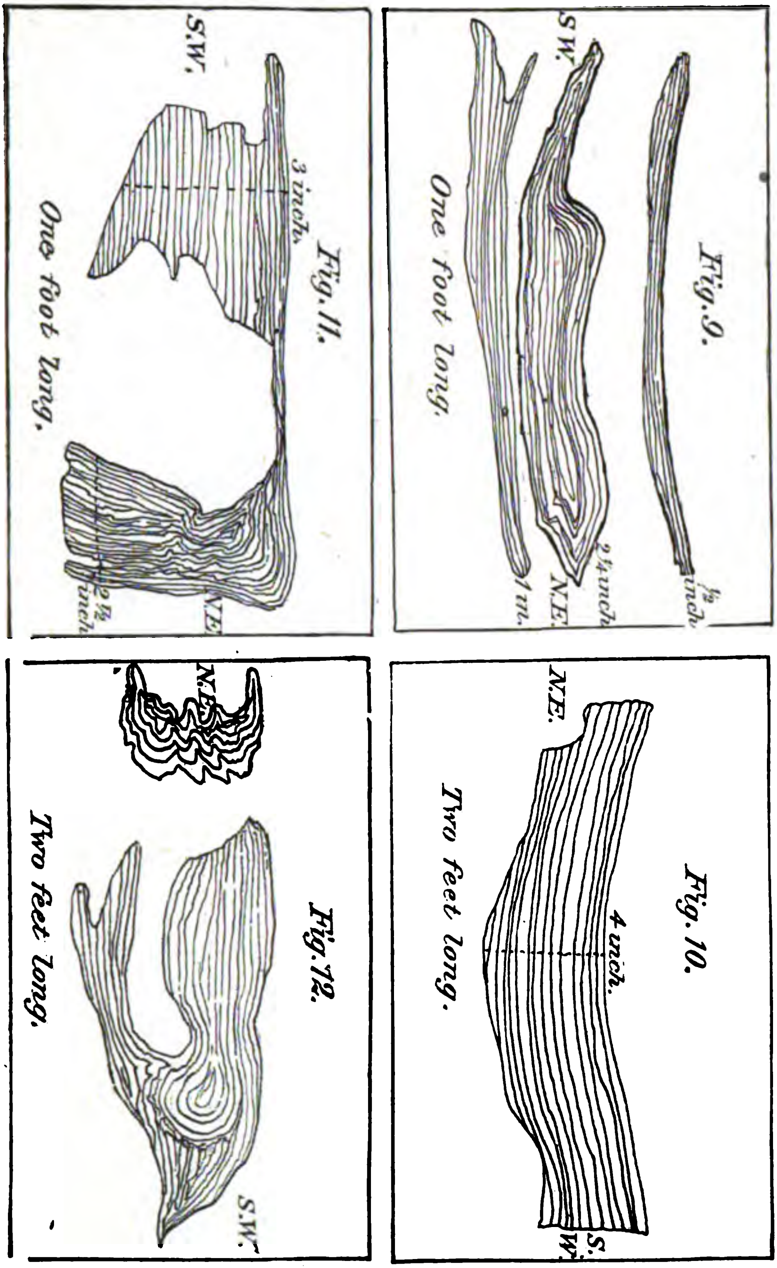


Fig. 8.—*Showing the manner in which a spur or "dike" of graywacke is thrust among the argillyte slate.* This is exposed on the surface of the rock eight feet, and is about six inches wide.

The crumpled condition of the slates at the end of this tongue

of graywacke indicates a forcible protrusion of the latter within the former. The same is indicated by the non-conformity of the graywacke with the sedimentary banding of the slate.

Figures 9, 10, 11, and 12 illustrate the manner in which isolated pieces of the slate are disseminated in the graywacke rock. In all these figures the lined portions represent argillyte, or argillitic rock, embraced unconformably in the midst of coarse-grained wackenitic rock, the sedimentary planes of the former running as shown by the lining.



Figs. 9, 10, 11, and 12.—*Showing isolated crumpled pieces of argillitic slate disseminated unconformably in graywacke.*

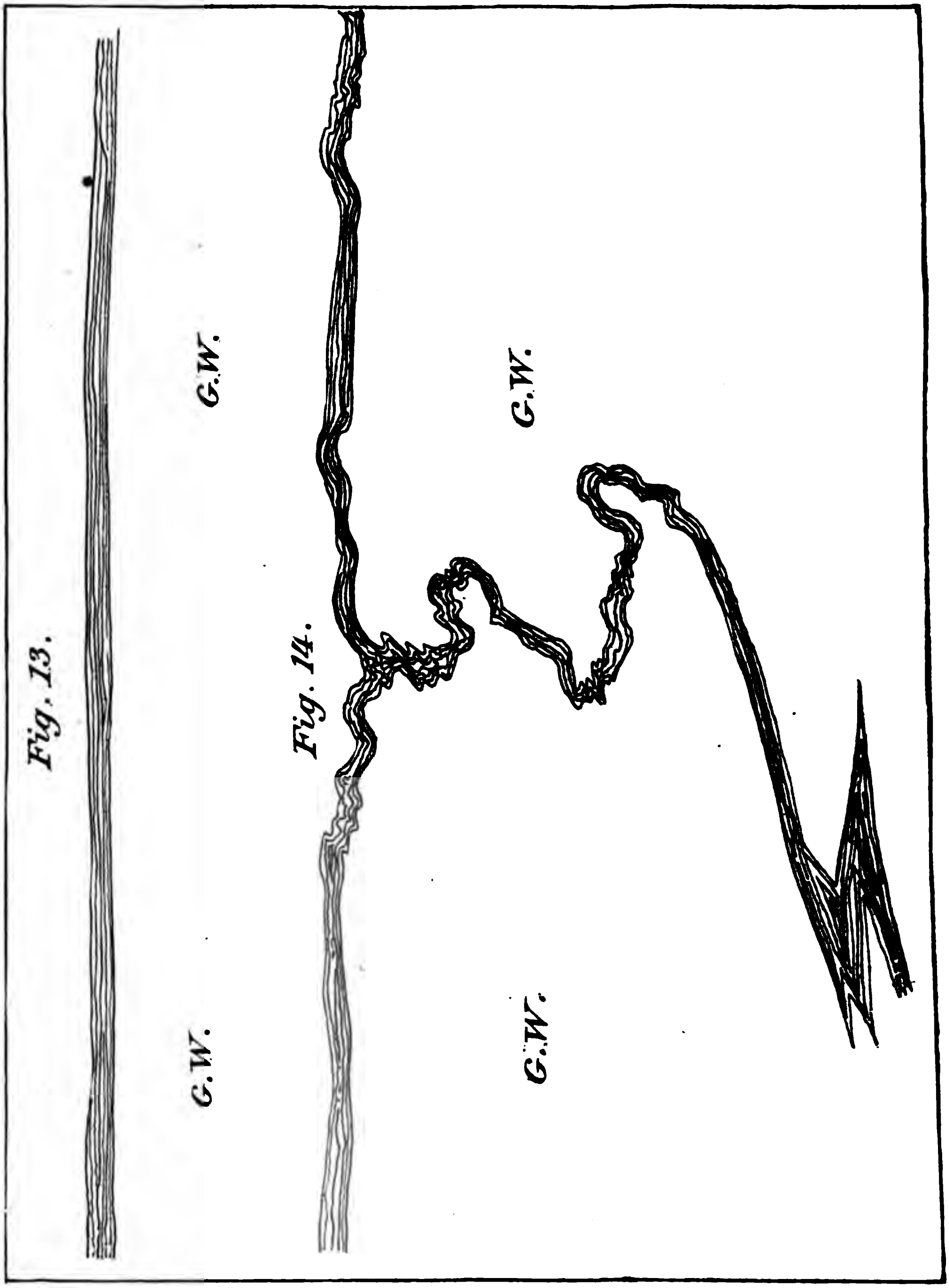


Fig. 13.—*Showing a straight argillitic band in close proximity to a crumpled one*— The latter seen in fig. 14.

Fig. 14.—*Showing crumpled argillyte protruding into graywacke. This has a fluidal structure (so called) parallel with the walls.*

Figures 13 and 14 are sketches of argillitic rock, running through graywacke rock, one belt being nearly straight and one crumpled. The straight one is about 5 feet long, and an inch and a half in width. The inclosing rock is graywacke in which no distinct bedding is visible.

Other similar sketches could be reproduced. One sketch in my note book shows a band of coarse graywacke, four inches wide and thirty feet long, running across the schistose structure, but rudely parallel with indistinct contorted bands of argillyte, or rock intermediate between argillyte and the graywacke of the band. This narrow band is looped repeatedly back on itself, in a close serpentine manner, some of the folds being so narrow and abrupt, where it was thrust back on itself, that the continuity of the band was broken and the short intervals were filled by the surrounding argillyte. Such fracturing, and thrusting of the "buckled elbows" of one stratum across those adjoining, on one side or the other, will account for the dike-like action of tongues and stringers of ore and jaspilyte which at the mines have the aspect of eruptive protrusions, if not for all the similar facts delineated by Dr. Wadsworth at Marquette.

These figures are intended to show that it is not an uncommon thing to see the firm sedimentary beds "buckling out" in protrusions into the softer ones. In case of fracture, under the process of upheaval, one of the edges of a jaspilyte layer might be protruded many feet into the adjoining beds; and when, in the operation of a mine, such a bed were exposed perpendicularly in the wall, it would at once suggest the eruptive origin of the bed, and inferentially of all the jaspilyte of the region. The same inference, however, would have to be extended, on the foregoing evidence, to the argillyte and the graywacke of the region, and indeed to all the rocks of the series, and they would all have to be pronounced eruptive.

Was the jaspilyte deposited as a sediment in its present condition? It is only necessary to call attention to a few facts which seem to afford a negative answer to this question. The region, and all the rocks of the region, have undergone a long succession of geological changes. The beds are upturned, nearly everywhere, to verticality, and have been folded, crushed upon themselves by pressure, heated by outflowing molten rock, and by intense chemical action, and permeated by superheated waters and gases. They everywhere bear evidence of secondarily deposited silica, and are recemented, in their fractured planes, by it and by other minerals. They have suffered decay in their long expos-

ure to atmospheric agents, and have been changed from their normal mineral constitution to greater or less depths according to the vicissitudes of exposure or protection. It is but reasonable to expect to find effects of these agents in the jaspilyte as in the other rocks. They are found in the jaspilyte. Many of the structural features that have been illustrated by the foregoing figures demonstrate the profound changes that have taken place in the ore-rock since its first deposition.

There are also mineral and chemical considerations, and facts that are dependent on chemical laws, exemplified in the minute structure of the ore-rock itself, which appear to answer this question negatively. Some of these have been mentioned in considering the jaspilyte as having a possible eruptive origin. 1st. The hematite has a relation to the bedded structure which indicates that it was not a part of the original rock, but was acquired subsequently, and was forced to take such positions and forms as the circumstances of the original rock would permit. 2d. The hematite is in a pure chemical condition, and exhibits crystalline faces and forms. These crystalline forms are mingled with the jaspilyte in innumerable places. They fill cavities or line them. They produce the fine scales that give the ore the characters of specular hematite. The hematite is interspersed with minute crystals of magnetite, and sometimes is largely replaced by magnetite, and sparsely by gœthite. The angular forms of the crystals are seen sometimes scattered through the reddish jasperoid rock, and even in the white quartzyte. So far as known, pure crystalline hematite is never deposited as a sediment. Limonite may be so formed, and it may subsequently be converted by dehydration and concentration to a pure hematite or to magnetite. 3d. The silica of the quartzyte is not in its original condition. It has already been stated that the grains of silica, when the "chalcedonic quartz" is disintegrated by weathering, are not rounded as if they had been deposited by the action of sedimentation. The grains of sand of the St. Croix sandstone are rounded as if beaten about on the bottom or on the beach of the ocean for a long period of time. Yet the chalcedonic quartz, when it is crumbled by atmospheric action, seems to be as uniformly granular as the St. Croix sandrock. It seems probable that the original grains, of which the quartzyte in the jaspilyte consists, have lost their rounded outlines by the deposition of interstitial silica, and that each separate grain acted as a governing centre, causing the inter-

stitial silica to arrange itself under the crystalline law governing each individual, along the axial lines of itself, until all the interstitial space had been occupied. Each grain which had been originally a rounded one became thus an angular one. When decay then operates to loosen these grains from each other, they separate first not from the silica which had thus been accreted to their surfaces, but along the planes at which the various grains in their growth had met each other. This depostion of interstitial silica in the quartz rocks of the northwest has been pointed out by Profs. R. D. Irving * and C. R. Van Hise. Such change in the form of rounded quartz grains has been shown by them to occur frequently, in quartzytes of nearly all the older formations, including the quartzytes of the iron-bearing rocks at Marquette, Michigan, but it has by them been regarded as not applicable to the most of the silica of the jaspilyte, which has rather been considered largely as chalcedonic and amorphous. In the opinion of the writer, however, all the so-called chalcedonic silica in the Vermilion region is granular, and its granular character can be recognized easily in the field, and all the sedimentary silica can be distinguished from the secondary chemical silica by outward visible characters. The "chalcedonic" silica seldom or never appears as a cementing material filling cracks and veins except by mechanical transposition but is confined to its interleaved position, between other beds of the ore-rock. It is not vitreous, but has a clouded translucency. The chemical silica is glassy and is apt to run transverse to all the grain and structure of the rock, filling such openings as had been produced by upheaval and fracture, and is never chalcedonic in the same manner as the fragmental bands.†

Was the ore the result of chemical, or metasomatic, change in sedimentary rock? It is most in keeping with the facts, taken altogether, to attribute such an origin to the ore. The ore, as a mass, embraces sedimentary rocks of varying texture and composition, and throughout it, can be seen the variations of texture and structure that only sedimentary action is known to produce in rocky strata. While this is fully borne out by the phenomena seen at the mines on the Vermilion range, it is equally true of the mines on the Gogebic range, at Negaunee, and at Black River Falls, Wisconsin. It is patent also to any geologist who carefully, or even casually, examines the structure at the small open-

* Bulletin of the U. S. Geological Survey, vol. ii, p. 195.

† See, however, rock sample No. 1013, where chalcedonic silica apparently acts as vein filling This subject needs further investigation.

ings that have been made on the Mesabi range. The nice and fine banding, which can be seen crossing the ore itself in the direction of the strike, as well as the coarser interlamination of sheets of ore with jasper or with quartzyte, the shading of the jasper into white quartzyte on one side and into merchantable ore on the other, the transition of the ore-rock into dark gray quartzyte, and carbonaceous slate (see rock No. 868 A—I.), as well as the conformity of the ore-rock in a general way, with the stratigraphy of the associated sedimentary rocks, are sufficient evidence of the original stratified conformable position of the rock which is the ore of the region, among the strata of the great series.

I have imagined that the hematite, as a superinduced feature of originally sedimentary rocks, had been substituted for some soluble or removable constituent, and perhaps by the removal of lime, since the present position of the strata was acquired, or contemporaneous with the acquirement of that position. The fact which is reported (if a fact) that some of the ore of the Gogebic range in Wisconsin is found to contain a percentage of lime that is counted on in the process of the furnace, seems to show it may not all have been removed there, whereas it seems to have been all removed in the Marquette and Vermilion ores—i. e., if it ever were present in these rocks. It may be supposed that alternating thin bands of fine siliceous sand, fine shale and a soluble limestone could, when the proper chemical agencies were brought to bear, be converted into the jaspilyte with all its banding, the fine sand becoming granular quartzyte, the shale becoming the red and brown jasper, and the limestone the pure hematite; when the shale had some ingredient of carbon it would make the black jasper, or the black siliceous slate (of photograph No. 13). The extreme fineness of all the constituent grains of this rock (the argillitic, the sericitic and the jaspilitic) would suggest the possibility of the accumulation of a fine-grained lime-sediment which would be subject to all the chemical enemies that carbonates encounter. But the relative time at which such a supposed substitution of iron for limestone may have taken place is yet with me a matter of uncertainty.*

It is no uncommon thing to hear the ore deposit spoken of as

* The foregoing paragraph, giving a supposed possible method of substitution of hematite for a carbonate, is copied verbatim from my notebook, bearing date July 17, 1886. Since then Prof. R. D. Irving has published a similar hypothesis, giving many facts to sustain it, in the *American Journal of Science* for October, 1886. (XXXII. (3), 255.) He, however, assumes the original carbonate to have been largely siderite, and that the chemical process was essentially one of "silicification," instead of ferruginization.

a *vein*, among the people and particularly the explorers, in that part of the state. The term is applied by the miners and the proprietors to the ore deposits of the Gogebic range in Wisconsin and Michigan. This is a very loose and incorrect use of the word. The ore deposit is in no case, so far as known throughout the northwest, found to take the form or have the origin of veins. A vein is a mineral deposit filling a fissure in the crust of the earth, the filling being done either by chemical secretions on the walls, or by injection of molten matter from below. In the latter case the term dike is applicable, and generally is used. But where the ore beds exist there have been no fissures in the crust. The ore is not arranged as ores are arranged in true veins. The ore is a changed rock-stratum; and it would be as appropriate to apply the term *vein* to a bed of marble, or a bed of granite, as to give it to the ore-bed.

2. THE IRON MINES AT TOWER.

In the thirteenth report of the survey some account is given of the mines and their products, so far as they had been developed at that time. Since then new facts have been discovered and much information of great interest has been obtained respecting the extent of the ore deposit, its geology, its quality at different places and its prospective value.

The principal active mines are still owned by the Minnesota Iron company, but several new mines have been begun.

Beginning at the most westerly of the mines, a brief description will be given of each, embracing such facts as have been ascertained by inspection, or from the proprietors, and such geological notes as have a bearing on the foregoing discussion. In these descriptions will be made references to the rock samples collected and added to the serial numbers of the survey.

The Lee mine is an east-and-west excavation in the eastern extremity of the *south ridge*. This ridge extends westward from the mine north of Tower nearly to Hoodoo point, and affords very valuable and striking facts bearing on the geology of the region. The excavation is 40 feet deep (June 17, 1886), and has followed the perpendicular quartzyte-jasper-hematite beds about fifteen rods, running westward with the strike of the strata. The open excavation is about 30 feet across, and the bedding is very much brecciated. The walls are the greenish schist (rock No. 869), but they widen out rapidly to the west from the point

where the work is now going on. Indeed the ore-rock is found 100 feet ± south from the schist which forms the south wall of the actual mine. It is very irregularly broken and twisted. It is necessary here to work over a great deal of lean ore and quartzyte rock. The hematite acts as a cementing material filling the crevices, etc., caused by the fracturing of the rock, and also permeating the formation coincident with the strata.

The men are now sinking a shaft to the second level, and have a second open pit about 45 feet across, nearly circular. In this pit, which is in the range of the main jaspilyte belt (or is supposed to be), the rock taken out, 50 feet below the surface, is very largely a breccia of green schist, or soft green rock resembling rather a shale in its conchoidal fracture planes, cemented by iron pyrites. The south wall of this mine, as shown in the upper level, consists of a breccia, or conglomerate-breccia, of jaspilyte and green schist, the former prevailing toward the north, and the latter toward the south. Such breccia, sometimes coarse, and sometimes conglomeritic, is found more or less throughout the Lee mine even in the body of the ore, much of it being worthless as an ore. Compare rock sample 912.

East of the principal active pit is an old opening at a lower level at which work has now ceased, apparently because the results were not good enough. The ore here is the same as at the main opening. The hematite seems to have been deposited in the interstices after the fracturing of the jasper and quartzyte beds, which are indescribably twisted, reversed and brecciated.

On either side of the ore-bearing rock appears the greenish schists (869). These are conformable in direction of trend with the general direction of the structure of the ore-rock, and lie directly in contact with the ore-rock. But they are highly ferruginous for a thickness of a few inches or a couple of feet from the ore-rock. The ore-rock apparently occurs in extended, irregular, sometimes lens-shaped patches in this schist. Taken altogether, however, it constitutes a great ridge or range of hills, and runs for an unknown distance, though the hills sink away into low lands at both ends. Perhaps the word *lenticular* is not exactly applicable here to the main ridge or grand trend of the ore-rock, though it is to some of the patches seen in the south ridge about a mile west of the Lee mine. Yet even here, at the east end of the east opening of the Lee mine, the schists crowd on the ore-rock and so narrow it up that it is soon lost under the drift, the

hight of the ridge also becoming less and less. On the north side this crowding is evinced not so much by a loss of layers in the ore-rock as by a change by which the ore-rock actually beomes greenish, then softer, yet reddish and hematitic and finally passes into the schist. This is in the direction of the strike. A large part of the product of the Lee mine is a second grade ore. Rock samples 871, and 871, A.

The West Breitung mine is not much worked yet, but has afforded some fine ore. This mine is the most westerly in the *north ridge*, yet is but little to the east of the meridian of the Lee mine. Here the strike of the quartzyte is very confused and twisted, there being above the mine (i. e. on the north side), a long stretch of jasper and quartzyte, running upward in the higher parts of the hill, that strikes nearly north and south.

The Breitung mine is quite near the West Breitung. It has been extensively worked, but now it is silent. It consists of a series of deep surface excavations that turn about, return obliquely through underground passages and open out in different directions, following the crumpled directions of the jaspilyte. The ore (i. e. the jaspilyte) is not very good, but much good ore has been taken out of this mine. The deposit is in broken and irregular masses, mingled with the prevailing reddened schist. In one place the jaspilyte seems to lie in heavy sloping layers, separated by a soft or at least an earthy crumbling substance. This is not a true sedimentary, nor yet an igneous superposition. The banding of the jaspilyte stands nearly perpendicular everywhere, or varies locally a few degrees from the perpendicular. It is placed alongside the schists which are sometimes nearly white and kaolin-like (No. 884) and sometimes of a brick-red color. Its line of direction or strike is very tortuous, even more tortuous than the shape of the mine would indicate. Indeed the direction of the minute banding has no relation to the direction taken by the mine, but that which governed the miners was the direction of the general trend of all the mass of jaspilyte. The fine banding sometimes runs at right angles with the general direction of the mine, and this is most noticeable at the place marked *D* on the following sketch of the plan of this mine. The schist here is often curiously basaltified, and covered with slickensided areas, when embraced between masses of the rock. The basaltic structure is sometimes curving, like some seen in the trap on the shore of lake Superior. The working of this mine has not exhausted the ore deposit, nor really developed its

width. This mine, toward the east, is directly contiguous with the West Tower mine. Rocks 884 and 916.

Fig. 15

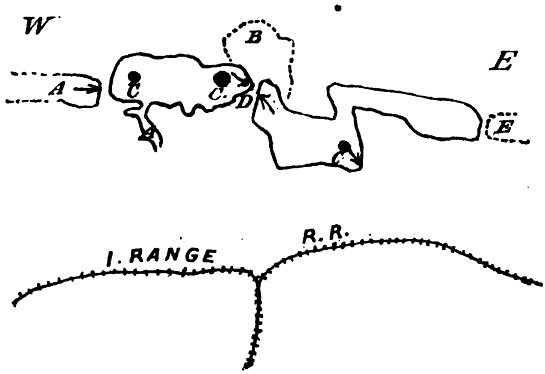


Fig. 15.— *Plan of the Breitung mine.*

EXPLANATION.

A. Cartways.
B. Underground excavation.
C. Deep shafts.
D. Shallow working connecting the two main pits.
E. Beginning of the Tower mine.
→ Mouths of tunnels.

The West Tower mine, in its chief excavation, is an open deep hole, but it has extensive underground chambers through which the product of the mine is carted to the railroad, and by which the different parts of the mine, such as other deep surface openings, are connected with each other. This mine is worked extensively now. The total depth is about 130 feet. The strike of the rocks here is somewhat more uniformly in an east and west direction, but still with much interior banding in the individual layers, in contorted courses. The walls are of jaspilyte, except a small exposure of schist near the east end, in the south wall. It is stated by one of the captains at this mine that the quality of the ore compared to the rock, and the amount of ore, do not change perceptibly as the working gets deeper. This mine is being extended east by a (now) shallow trench.

Fig. 16.

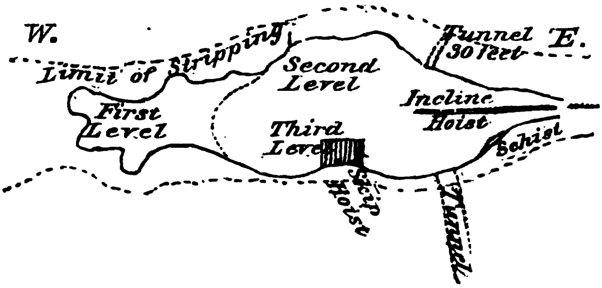


Fig. 16.—*Plan of the West Tower mine.*

The East Tower mine is one of the most productive of the Vermilion range. Four small cars are loaded simultaneously, each one carrying an average load, as stated, of about 5,000 pounds. Four hundred and fifty tons per day are taken from this mine, and seven hundred tons per day from the two Tower mines. Sixteen men are continually shoveling ore into the cars, there being no need of assortment. With diamond drills and steam power, holes are made in the mass of the ore above the level on which the cars run, suitable for a charge of powder. The larger masses too large for handling, resulting from the blasting, are broken by hand sledges, but the most of it is ready at once for loading in the cars. This mine shows the most ore, and the purest great deposit yet found. The walls are entirely in ore. The tunnel running south carries the ore to the pockets which convey it, as wanted, into the railroad cars. The tunnel is cut wholly in green schist which shows a distinct dip north, about 85 degrees (sometimes 80). At the mine the south wall overhangs on the schist; but the work has not gone far enough to reveal the north wall. The product of this mine at present is carried out entirely through the tunnel, without any hoisting. The pit is about 75 feet deep, and 100 feet in diameter, nearly circular. The ore of this mine is represented by rock 876.

Fig. 17.

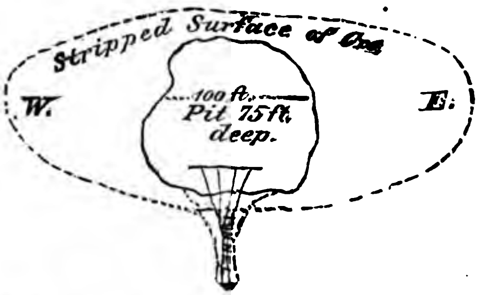


Fig. 17.—*Plan of the East Tower mine.*

The West Ely mine is a simple open pit from fifty to sixty feet in diameter and about fifty feet deep, without having as yet developed a great amount of good ore. The excavated rock is quartzyte and ore, with some schist. The gang of men is small, and the hoisting is done by bucket and horse-power. A sketch of the east face of this mine is seen in figure 1. At this pit the ore is interbedded distinctly from top to bottom, between strata of schist, dipping from 85 to 95 degrees toward the north. No ore has yet been shipped.

Fig. 18.

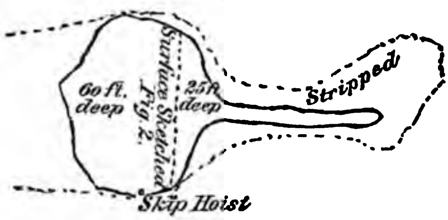


Fig. 18.—*Plan of the East Ely mine.*

At the *East Ely mine* the alternation of ore and ferruginous schist is also distinct. For an illustration of this see figure 2. The dip is the same. The schist and ore are roughly cross-jointed, and in angular blocks, but the ore shows this structure most pronounced. Much work has been done at this mine, and a large daily shipment of ore is made.

Fig. 19.

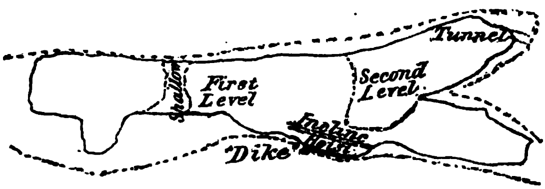


Fig. 19.—*Plan of the Stone mine.*

The Stone mine has been considerably more worked than the East Ely, and consists in the main of a deep trench about forty feet wide, and from forty to eighty feet deep, running about east and west following the course of the main mass of jaspilyte, and about two hundred and fifty feet long. At the east end of the mine the schists, which everywhere constitute the walls at this mine, have a general dip to the north, about 86 degrees. In some places, however, they stand apparently about vertical. They exhibit the hardened, reddened and less schistose, or more coarsely schistose but somewhat jointed, structure which has been attributed to the heating effect of the jaspilyte on the theory that the jaspilyte is of eruptive origin. (Rock samples 890.) This reddened schist seems to have lumps of chlorite, or a chloritic mineral, and perhaps of other minerals, originating in it, as if an incipient recrystallization had been retarded and stopped. In other places this schist shows a similar condition when inclosed between the strata, or belts, of the jaspilyte. Again, in other places this schist is less lenticularly schistose, but, while redder, and jointed more at right angles, it is equally soft. This change in the schist from soft, green, fissile rock, is attributable to the same cause that produced the general ferruginization of the formation, and gave origin to the hematite of the jaspilyte. If it be a baked condition of the schist, the heat necessary may have been derived from the mechanical action of the firm jaspilyte on the schist at the time of the upheaval and fracturing, augmented by chemical action.

The reddened schist sometimes also is banded in a manner similar to that seen in the jaspilyte, and can present a claim, on that account, as valid as the jaspilyte, to a fluidal origin (Rock sample No. 891). There is also, where the sample No. 891 is taken out, a coarse banding in the jointed clay, consisting of more and more, or less and less, ferruginization, parallel to the

banding of the jaspilyte and probably due to the same cause. This, however, is not so marked as in the jaspilyte, but consists of purplish-black, brown, and light-red stripes, the latter being also seen on sample No. 891.

There is a belt, or stratum, on the north side of the mine, at the east end, about a foot thick, where No. 891 is taken out, where this clay becomes firmer and firmer, and even siliceous and hematitic at the centre, where the banding is much more like jaspilyte. This belt increases in importance as an ore, upward, and was taken off, with the operation of the mine. It becomes two belts each about a foot wide, separated by a stratum of red schist.

In this schist are lenticular masses of quartz, quartzyte (these perhaps of chemical origin by segregation), and of banded jaspilyte. These jaspilyte masses are sometimes thin, and interrupted in their courses, and very frequent in their alternations with the schist. To regard them as anything but of original sedimentary origin, though now mechanically, and perhaps chemically segregated into lenticular masses, or pipes, or wavy sheets within the schists, seems impossible and almost absurd. Yet to this *reductio ad absurdum* consequence is the eruptive theory driven, for there is a perfect gradation from the great ore masses to these thin sheets and lenticular masses.

In order to explain this peculiar manner of distribution of jaspilyte, on the eruptive hypothesis, these isolated sheets and scattered lenticular masses, are not admitted to have been isolated from their parent mass, but, before the opening of the mine, are supposed to have been connected with the great jaspilyte lode, such connections now being destroyed by the operation of the mine. Thus they are supposed to have come, at the same time, from the same deep source as the rest of the jaspilyte. It is obvious that from the nature of the case, when one of these is seen inclosed in the schist, one end, or one edge, is seen uncovered, and that end, or side, in Dr. Wadsworth's opinion, had a connection with the parent mass. It thus makes no difference from what direction these are viewed, from above, below, from the right or left, there is no demonstration of their entire lenticular inclosure in the schists, however patent it may appear. When they terminate on the surface of the weathered jaspilyte, before the working has begun, they can be said, safely, to have a deep-seated connection with the main mass. When the mine is opened, and such lenticular masses are found to taper

out downward, and to be overlapped to the right or left by others, an intelligent captain could observe the facts and bring evidence pro or con as to the actuality of their supposed union with the main lode. This question was asked one of the foremen at the Stone mine, in the presence of Dr. Wadsworth. He said they frequently ran out to points downward and ceased to be of any value as ore. But subsequently he told Dr. Wadsworth that they never do.

The following sketch, Fig. 20, shows a lenticular mass of jaspilyte at the east end of the Stone mine, inclosed in contorted and more or less "baked" schists. The end exposed, which faces west, is supposed, on the theory of Dr. Wadsworth, to have been connected with the main body of ore, which now has been mined out. This can not be denied now, and seems plausible from the fact that toward the east this branch of the main ore deposit became narrower, and so unimportant that the work in that direction finally ceased, the running of it out being in keeping with this lenticular mass. The sketched mass is about four feet long perpendicularly, and thirty-five feet below the natural surface of the ground.

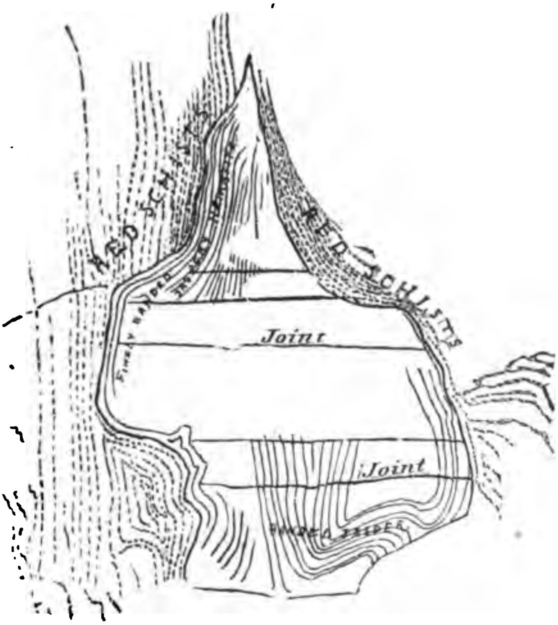


Fig. 20.—*Lenticular mass of jaspilyte in reddened schist at the east end of the Stone mine.*

In the Stone mine, near the north wall, about seventy-five feet below the natural surface of the ground, is what appears to be a lenticular mass of jaspilyte, lying between schist, on the north side, and a contorted band of hematite, on the south side. The lower portion of the rough hematitic rock has been quarried away. Owing to some sinuosities in the line of excavation the profile of this part of the north wall shows the relation of this jaspilyte to the schist and to the rough nodular hematite, as in the figure below (Fig. 21). This jasper (No. 892) is apparently granular in the same manner as that at the natural surface, having, in its whiter portion the same clouded translucence; and this would indicate that the usual granular condition is not owing to incipient decay.

Fig. 21.

N. S.

Fig. 21.— *Clouded translucent or "chalcedonic" jasper seventy-five feet below the natural surface, in the north wall of the Stone mine.*

In the Stone mine, near the place of the last, but on the opposite side, is a broken and angular condition of the jaspilyte, now being mined. This is about 80 feet below the surface, and the sinuous course of the banding is shown by Fig. 22. When this rock, so mined, separates in the planes coincident with the sedimentary lamination the cleaved surface is specular, and the ore is specular hematite.

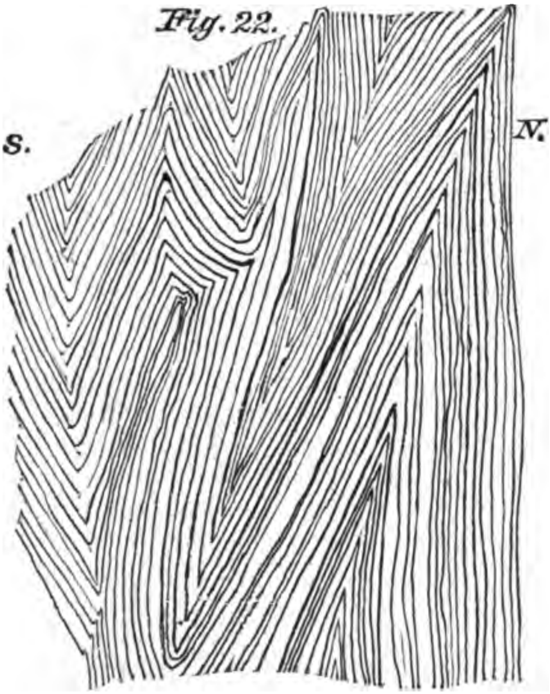


Fig. 22.—*Showing the banding of the jaspilyte in the Stone mine. The surface sketched is perpendicular.*

Farther west, in the Stone mine, a bedding structure passes from the red, "baked" clay, so called, into the jaspilyte, conformable throughout in its bending course. If one is sedimentary the other is. This is not the schistose structure, but the bedding of the clay, forty feet below the surface.

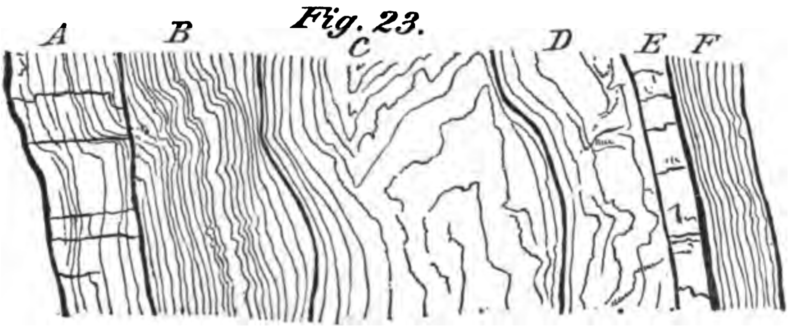


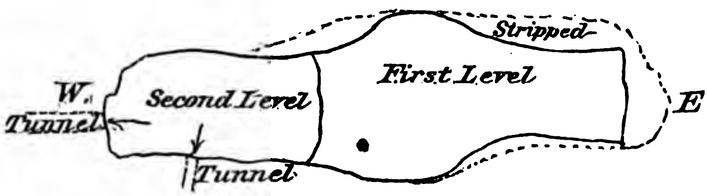
Fig. 23.—*Showing a sedimentary structure continuous conformably from the "baked clay" into the jaspilyte; west end of the Stone mine.*

EXPLANATION OF FIG. 23.

A. Band of rough jasper, eight inches wide.
B. "Baked clay," ten inches.
C. Banded jasper becoming broken, twenty-eight inches.
D. Red schist, eight inches.
E. Hematite, four inches.
F. Schist, six inches.

At the west end of the Stone mine the south wall suddenly makes a bend to the south, the jaspilyte bursting southward. The distance this flexure extends is not shown yet, but it is being uncovered. The north wall does not show this irregularity, at the same place; but a little further west there begins to appear a slow flexure, on the stripped, but unmined, upper surface of the ore, the bands all turning off toward the north. Although the banding in this protrusion is generally broken and confused, it stills runs mainly in an east and west direction — at least it is not parallel with the sides of the mine, as would be expected if the jaspilyte in a molten state flowed into an opening at this place.

Fig. 24.



The Stuntz mine is next east of the Stone mine. Here can be seen a stratified alternation of layers of jaspilyte and schist, similar to that seen in the Stone and Ely mines, there being visible three schist bands from six to ten feet thick, dipping N. or N. N. W. at an angle of about 80 degrees from the horizon. The opened mine runs about east and west and is about two hundred feet long. It shows two levels, from the lower of which a tunnel passes southward for carrying away water and rock, and a drift has been run westward following the ore, with a view to working out above.

Fig. 24.—*Plan of the Stuntz mine.*

The product of the mines of the Minnesota Iron company:

1884	62,124 tons.
1885	225,484 tons.
1886	304,396 tons.

In March, 1887, the following statement was made of the mining equipment of the foregoing mines:

The machinery at the mines embraces two compressors, 20 inches in diameter and 30 inches stroke, operating 30 Ingersoll rock drills in the various openings. Six steam engines drive six hoisting drums, 5 feet in diameter, and also Winze hoists which operate the 11 skips and hoists in the various excavations. Some of the skips are the ordinary iron bucket with wheels and bail, which are automatically dumped at the summit of the skip. Others are platforms on which cars are run at the bottom of the opening and lifted to the surface where they run off on other tracks. Cables are also used to handle cars through a tunnel leading from one of the openings to the dump piles. In one case nine cars are raised from the pit by a boom derrick to tracks at surface level, and in another a counterbalance with pulley sheaves returns empty cars up a long incline which they descend when loaded. Two twenty-light dynamos, driven by an independent engine, furnish light for operating the mine continuously throughout the year. To provide for shipping the ore during the six or seven months when navigation is opened, part of the ore must be mined and stocked in winter. The rigor of the winter in northern Minnesota would seem to preclude active operations in the open pits, but captain Morcom stated that although during the season just closed the thermometer at times indicated thirty and forty degrees below zero, work had not been suspended day or night, the dry, still atmosphere making it possible for labor to be performed with less discomfort than in other regions where a higher winter temperature is accompanied with dampness or penetrating winds.

Quality of the Minnesota hematite ores. The ore is very hard, and must be removed by explosives, dynamite, with about fifty per cent of nitro-glycerine, being chiefly used; but the hard character of the ore has its compensation in furnishing firm pillars for future underground working, and in being richer in metallic iron than the softer ores. Much of the ore is massive or structureless, but sometimes it takes the aspect of specular ore. In physical character the ore closely resembles that taken out of the Champion mine in the Marquette district, and some of the best specimens from the Ashland mine in the Gogebic region.

The chemical analyses, made at the mines by Mr. F. Prince, the assayer of the company, show a high range of metallic iron, and a low percentage of phosphorus. By the

courtesy of Mr. C. Tower, Jr., the managing director of the company, the results of assays made during a period of three months were examined, and an average of 115 analyses showed the following rates. These were on samples taken from the stock-piles in the daily operation of the mines.*

Iron	67.70
Phosphorus	0.06
Silica	1.50

The lowest determination was: Iron, 65.29; phosphorus, 0.067; silica, 3.79. The highest was: Iron, 69.28; phosphorus, 0.0849; silica, 0.68.

The phosphorus in the Vermilion ores varies from 0.021 to 0.110, but in most of the ore as now found it is between 0.04 and 0.07, so that the company can readily maintain a guarantee of 0.06 or less of phosphorus.

The following are complete analyses of the ore taken from the different stock-piles and analyzed by Mr. Prince:

Iron	67.99	68.37	68.32
Phosphorus	0.053	0.057	0.046
Silica	1.35	0.10	1.3
Alumina	undetermined	0.10	0.25
Magnesia	"	0.014	nil.
Sulphur	0.005	0.007	nil.
Loss by ignition	undetermined	0.56	0.06

It is noticeable that the leaner ores are of practically the same composition, except as to silica, as the rich ore, indicating that the inferior ores are those which, lying near the walls or horses of rock, carry free silica. In mining this ore, as above stated, two grades only are made; the great bulk of the ore (fully five-tenths of all that is mined) is sold as "Minnesota Bessemer" and is guaranteed to contain: Iron, 67½ per cent or over; phosphorus, 0.06 or under; while the second grade of ore, "Red Lake," is merely the ore which, being mined close to the walls or "horses" of rock, has more free silica, but is sold to yield iron 62 per cent or over; phosphorus, 0.06 per cent or under. In mining the ore the walls are fairly well defined, so that comparatively small quantities of it are taken off with the ore. The dump piles of refuse would, however, show from 25 to 45 per cent of iron.

To indicate the character of the ore chemical analyses may be quoted, but a more reliable index is in the fact that the Minne-

* John Birkinbine, in *The Iron Age*.

sota Iron company have made one contract for the current year, which is for the delivery of 135,000 gross tons of ore guaranteed not to average below 67½ per cent metallic iron, and with phosphorus not to exceed 0.06. In addition the company will ship over 200,000 tons of ore guaranteed to average at least 67 per cent of iron, with phosphorus 0.06, and 40,000 to 50,000 tons of ore guaranteed to show between 62 and 64 per cent of iron, with phosphorus at 0.6 per cent. There are one or two companies who could deliver large amounts of ore as rich in iron and as low or possibly lower in phosphorus, but there is probably no other iron ore company in the United States that would undertake to meet the above guarantees for 350,000 tons of ore in 1887.

The product of the mines of the Minnesota Iron company, in the third year of its existence, raises it to the second place among the ore-producers of the United States.

3. THE MINES EAST OF TOWER ON THE VERMILION RANGE.

In the fall of 1882, H. R. Harvey, an experienced miner and explorer, started eastward from Tower, then consisting of one small log cabin, and cross-sectioned the country until he found some good iron indications in section 13, township 62 north, range 13 west. Winter coming on, a stop was put to his explorations for the year, but the next spring—1883—he renewed his explorations. At the same time Emil Hartman commenced investigating the same field. Both worked from nearly the same point, following up the floats of iron ore and jasper until they worked themselves into the town of 63-12. Mr. Harvey found here in section 27 the outcrop of ore which is known as the Pattison find.

This property is now leased to the Pioneer Iron Mining company. Mr. Hartman, who worked about two miles further east found the outcrop on section 25 in same township, also the outcrops on the Eaton & Merritt claim. In regard to the latter find, Edward Byrne was a few days ahead of Hartman, and is entitled to the honor of the first find on section 30, township 63, range 11.

The first property east of Tower which was brought to development was the north half of the northeast quarter of section 27, town 63, range 12 west. This was done by Mr. Harvey, accompanied by a few men, in the winter of 1885–'86. They worked during the intense cold of a winter in northern Minnesota, with poor and insufficient tools, and opened several test

pits, in order to find the extent of the ore deposit. In the season of 1886. however, none of these could as yet be strictly called mines. No ore had been shipped from them although some good specimens had been taken away for assay. The workings consisted of exploratory pits and trenches. Harvey's pits were six or eight in number sunk to the bed rock through six to ten feet of drift, in some places revealing a jasper-hematite rock in banded striping. At but one point could the dip and strike be seen, owing to the filling of the pits by fallen earth, or by water. At that point the dip was 60 degrees toward the south, 50 degrees east, and the strike was north, 40 degrees east.

One of the most important workings was found in the S.E. ¼ S.E. ¼ of section 28, 63-12, where some trenches had been dug by the owners. They are from two to four feet deep, and in some places they seem to have met with the bed rock but for the most part they are not yet through the surface drift. These surface materials contain not only some first-class hard hematite ore, but also are permeated by and intermixed with much soft hematite, presenting in their finer parts very much the aspect of the "soft ore" deposit of the Gogebic range at Ironwood, indicating the near proximity of considerable deposits of iron ore, though not yet struck in any of these trenches.*

Some drilling and blasting had been done in some jaspilyte ridges in section 30, 63-11, near the north side of the section, but no systematic work had been prosecuted.

Besides these, no working for iron was encountered at any point east of Tower.

In the fall of 1886 a great many explorers visited the region through which the strike of the iron ore was thought to extend, and many additional discoveries were made, beyond what was known at the time of this season's work. At several places land had been taken by "homesteaders" on which, with a scanty prospect of successful farming, were much better prospects of successful mining. These frontier scouts are very persevering and hardy, and they run over the whole country far in advance of any systematic surveying, and of all organized attempts at exploration. They are the *avant coureurs* of settlement. They never settle. They rarely reap adequate financial returns from their discoveries. If they sell out to good advantage the proceeds are generally squandered in dissipation. They are then ready for another similar campaign.

* Mr. Sheridan submitted some of the hard ore from this location to Mr. Prince for analysis, with the following result: Metallic iron, 68. 24; Phosphorus, .026; Silica, 1.61.

4. GEOLOGICAL DETAILS.

Terms defined. In the notes and descriptions which follow, some common geological terms are frequently employed. Yet, though so common, and perhaps because so common, they are apt to be misunderstood, and differently applied, unless, at the outset, there be a definite understanding and limitation of their intended significance. It is to obviate this difficulty that the following definitions are given.

Bedding structure, is that banding of different colors or shades of color, due to weathering usually, which is brought out on the surface of the sedimentary rocks when they are tilted so as to expose the edges of the bedding. For this term the words sedimentary structure are used in some cases.

Schistose structure may run at any angle with, or coincident with, the bedding structure. It is an imperfect cleavage that is developed in massive rocks, whether sedimentary or eruptive, which on weathering brings to view a finely jagged outline at the broken or eroded ends or edges of rock beds, but not making a real slatiness. Such rock masses appear often quite homogeneous or massive until weathered. It is due to an elongation of the grain and fibre of the interior of the rock in a uniform direction. This structure passes into the next. It is most perfectly developed in old eruptive rocks, while the next is most perfectly exhibited in sedimentary rocks.

Slaty cleavage is the extreme development of the schistose structure in sedimentary rocks such as the graywackes and argillytes. It may cross the sedimentary banding at all angles, or it may coincide in direction with it. It produces cleavable slates, and it hastens the destruction of many rock-bluffs that can not be cleaved into slates, because it opens to the weather innumerable seams, where moisture enters. This structure should not be confounded with a slatiness that is due to the separation into slates of an argillitic, or other rock, along the natural sedimentary planes. This structure is supposed to be produced by great pressure exerted perpendicularly to the cleavage planes.

Foliation is a term used to express the semi-luminated structure of gneiss. It is applicable to crystalline rocks only. It implies a rearrangement of the elements of the rock so as to cause a leaved or sheeted alternation of their beds of different minerals, though each bed generally shades imperceptibly into those on each side

of it. It is supposed to be due to an altered sedimentary structure, and hence is coincident in direction with it.

Strike, whenever mentioned, refers to the direction of trend of the basset edges of outcropping tilted rocks, generally sedimentary, but it is equally applicable to bedded igneous rocks.

Dip is the inclination of the sedimentary bedding planes, expressed in the angle they form with the horizon.

Directions are referred to the true north, a uniform correction of ten degrees having been made, at the time of the observation, for the variation of the magnetic needle to the east of north.

THE NORTH AND SOUTH RIDGES AND THE REGION ABOUT TOWER.

The nucleus of the "south ridge" is jaspilyte, but it has on its flanks other rocks pertaining to the same series, particularly on the south slope, and in the vicinity of Tower. The ridge runs a little south of east, at the west end, averaging about twelve degrees south of east, but the banding of the rock fluctuates considerably. It rises, by aneroid measurement, at the west end 190 feet above Vermilion lake.

The bedding of the jaspilyte, which is smoothed by glaciation, stands nearly vertical, but in some places, separated from each other several hundred feet, it varies either to the north or south a few degrees. The average character of the brown jasper and hematite is expressed by rock number 866.

There are some considerations bearing on the origin of the jaspilyte, which are suggested by a casual examination of appearances on this ridge.

1st. The white quartzyte, appearing amorphous, or chalcedonic, or flinty, on weathering, and especially on those angles where the fires that have prevailed here have had effect on it, becomes granular, and separates into a "scouring sand" of a fine quality, when pounded with a hammer. The brown quartzyte, or some of the so-called jasper layers, act in the same way. These grains of quartz, of nearly uniform size, are very fine, but can be seen under a good hand magnifier.

2d. In some of the beds, both of the white and of the brown sandstone, a distinctly bedded structure, consisting of bands of different shades of color alternating, is plainly visible. It seems as if the collecting of the hematite was most impeded by the siliceous bands, and was carried to its fullest extent in such as

could be entirely replaced. The argillaceous bands, now forming jasper of reddish and brown colors, are intermediate in this graded transformation. The fine banding supposed to be due to sedimentation is visible on several of the samples. No. 867.

3d. The great thickness of the ridge (at least 200 feet), showing the bands standing nearly vertical, if of igneous origin and hence uniformly fluidal at the time it reached the surface, would seem to require that a great fissure was opened and allowed a great discharge of fluid matter, such that the fluidal structure would not be found always standing in the same position and coincident in direction with the sedimentary structure of the country rock. It should be found flowing unconformably over the other rocks.

There are nodules, embraced within the jaspilyte, varying from two to three feet across, accompanying patches of greatly contorted bedding, that seem to show a fusion of this rock. The resulting crystalline rock is represented by No. 866 A. Similar locally fused patches are visible in some places in the graywacke beds, as will be noted at points on the south shore of Vermilion lake. This fusion was due perhaps to pressure and mechanical friction.

This ridge shows a great deal of fracturing, jointing, re-cementing, faulting and twisting of all the visible structure, particularly of the sedimentary structure.

The cementing material in some cases is quartz, of which one vein over a foot in thickness is seen at the west end of the ridge. In other cases the cement is hematite, and this is visible in some of the small fault planes.

At a point about 100 feet above the lake, at the west end of the ridge, but on the southern side, the jaspilyte shows a graduation, across the bedding structure, into other rock like that of the country. (No. 866 B.) This is a gray, fine quartzyte, and is in contact with jasper and hematite, though these are not so characteristically developed as in the ridge proper.

Toward the east the direction of the jaspilyte banding changes, and runs about 12° N. of E. There is a sudden downward jog in the line of the crest of the ridge, but as a continuous ridge of less hight it extends as far as the Lee mine east of Tower. Throughout the rest of its course, however, nearly to Tower, and north from Tower, it exhibits a different geology. The jaspilyte is interrupted, but occurs as isolated masses to a point nearly north from Tower. It is embraced in a green schist, which is the same as that seen at the mines, especially at the Lee mine.

This green schist is a puzzling rock. It acts, in its embracing relations to the jasper rock like an eruptive rock. It surrounds large and small masses of it. It runs with long tongues into it. It winds about and between pieces of it. Some of the embraced pieces of jaspilyte maintain in their bedding, and in their linear extension, an average parallelism with the rock of the main ledge, and to the schistose structure of the schist. Others are brecciated and twisted out of such parallelism. Yet in nearly all its parts, whether in tongues, bands or great masses, this schist keeps its direction and homogeneous composition. But in some places, when crowded between parts of the brecciated jasper and quartzyte, its schistose direction is diverted into a partial conformity with the outer surfaces of those quartzyte masses.

Some of these jasper masses have acquired a pseudo-basaltic structure, from some cause, as if from the effect of this rock, and some of them are blackened as if partially baked, when inclosed entirely within it.

Although these irregular masses, and all the jasper masses involved in this conglomerate, are somewhat ferruginated, they do not anywhere form a genuine iron ore — while some of them are a nearly clean white sandstone. Indeed some of the large pieces are of white sandstone, or arenaceous quartzyte.

Since these are so nearly connected in mineral characters, with the jaspilyte, and can not easily be separated from them except by the less amount of iron present, it would seem that the jaspilyte must have been jaspilyte before the distribution of these fragments, and that therefore this rock (i. e. the rock containing the fragments) can not be of coeval date with the jaspilyte.

Passing southeastwardly from the east end of the high crest of the jaspilyte ridge, already mentioned, the succession of strata passed over may be expressed by the following diagram.

Fig. 25.

Fig. 25.—*Diagram of the strata extending southeastwardly from the "south" ridge, on N. W. ¼ of the N. E. ¼ Sec.* 32, 61-15.

There is a precipitous descent from the main ridge down to the level of rock No. 868, which is a subcrystalline rock having the appearance of being igneous. This rock occupies an interval of perhaps sixty feet. It is brownish-red, contains quartz (sub-rounded), feldspar, and chlorite. The structure is massive, or basaltiform, and it weathers away faster than the rock on either side of it. Its contact with the other rock can not be found easily.

On the southeast side of this appear many irregular masses of jaspilyte. Indeed there is so much of this rock, though broken and recemented, that it appears to be a recurrence *in situ* of the formation of the main hill. Those parts nearest the rock 868 are a real conglomerate, very coarse. This, however, is much less red and hematitic than in the large ridge, the quartzyte being white and black, in narrow bands, both sometimes showing a red color. The appearance of this conglomerate is that it dips under the rock No. 868, and lies on and in rock No. 869, which is a light greenish, soft schist having a strong and persistent schistosity that runs about east and west. This schist extends to the first hills north of Tower, and occupies a belt at least 80 rods wide, becoming invisible by reason of the drift.

In the line of strike of this schist belt, somewhat toward the east from the east end of the main ridge, is an outcrop of argillyte, which appears to be an incidental phase of the schist, as it seems to fall, in stratigraphic order, into that interval which, further east, is wholly occupied by the foregoing schistose rock. In this argillyte is a perfectly plain sedimentary structure, varying in its dip from 75° N. to perpendicular. The slatiness coincides with the sedimentary structure. The clay slate can be seen, on the north side of the exposure, to graduate into a sericitic schist. The width of the clay-slate belt, paced north and south, is sixty-three feet.

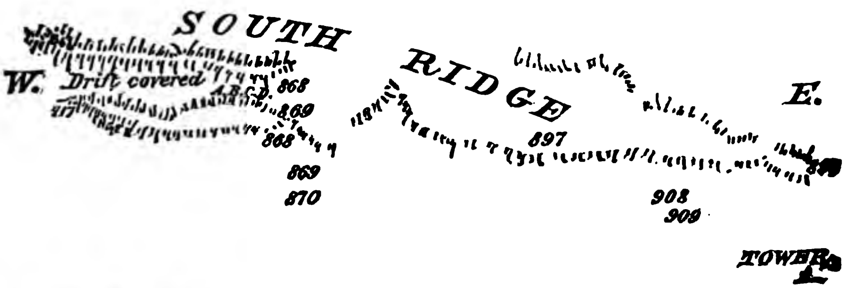
At a point due north from the clay slate there are two belts, or exposures of the rock 868, one being north and the other south of the brecciated and conglomeritic belt of the jaspilyte, but both of them in the subordinate lower ridge. The southern belt makes a precipitous and bold bluff just north of the clay slates, rising forty feet nearly perpendicular.

This rock (868) has in the main everywhere the same general eruptive facies, and it graduates into the green schist that embraces the angular transported masses of jaspilyte seen in the second, or subordinate, ridge. It is much

obscured by the accumulation of coarse drift which everywhere lies on the southerly side of these ridges in considerable abundance. It is cut by lenticular masses of white quartz, and these are so long sometimes as to appear like veins. It is not conspicuously, or regularly basaltic, but has irregular fissures and joints that divide it. It is massive, firm and granular. It is only scantily affected by any gneissic or schistose structure, yet there is apparent, near some of the quartz veins, and along some weathered angles, a schistosity that has the direction of the more finely schistose structure of the rest of the associated rocks. On weathered surfaces it shows a roughly granular aspect, the projections being of feldspar mainly, but sometimes of quartz. Further, there are seen, scantily, impressions of rounded boulder-forms on the weathered surface, and sometimes rounded forms still embraced in the rock. Illustrations of this rock are Nos. 868 to 868 D.

The following figure (26) is a sketch map of the place where the foregoing notes were made, and will give an idea of the geographic positions of the various rocks, and of some others noted below. It embraces the western half of the south ridge:

Fig. 26.



At the extreme west end of the subordinate ridge, west of the locality above described, the rock is bare, and crumbles, causing a sliding lot of debris, consisting of jaspilyte and disintegrating jaspilyte or sandstone (No. 917). The crumbling down is like a sandy bluff, somewhat rusty, but yet a good part of it consists of harder jaspilyte showing the contorted bands peculiar to it.

Further east, on the "south ridge," were made numerous observations on the structure and relations of the various rocks of which it is composed, some of which have been given in discussing the iron ores of Minnesota in a former chapter. Numer-

ous sketches were made here, and several photographs, which will have to be reserved for some future report.

One interesting fact, however, should be mentioned. Not far northwest from Tower is a conglomerate which has the matrix of the jaspery conglomerate in which are embraced the numerous large masses of jaspilyte, but containing also quartzyte, both white and gray, and black siliceous slaty jaspilyte. Among these are also a few pieces of rock that resembles graywacke, or porodyte. The matrix is a coarse, but rather soft greenish schist, apparently passing into porodyte (No. 908). There is a rude structure which has a resemblance to that due to sedimentation, which is about vertical, and strikes 20 degrees south of east. This conglomerate differs from that seen at Stuntz island in having a greater number of jaspilyte boulders, and a smaller number of poroditic porphyroid pebbles.

At a point on the "south ridge" nearly north from Tower a dark slaty quartzyte, or "black slate," stands conspicuously out to view, forming a crag which overlooks the valley toward the south. This slate is bedded by sedimentation and stands about vertical, or dips slightly to the south. It is one of the conditions of the jaspilyte, and is similar to the slates seen in the group further east that have been called the *Animikie slates and quartzytes.* It is the same rock as some of the pieces included in the conglomerate last mentioned. It is situated south from the strike of some of the belts of schist that are supposed to have been unconformably deposited on it, but to the north of others. It is further north than the outcrop of the mixed conglomerate last described, and it may be supposed to have given origin to the rock fragments of this kind seen in that conglomerate. The line of contact between this black slate and the green unconformable schist is seen to show an abrupt transition, and is traceable for some rods to the east of the slaty crag, the green schist being hardened and ferruginated. A little further north is a belt of jasper masses included in the green schist. The situation seems to indicate that the black slate and jaspilyte are parts of the same general formation, and that being firmer than the intervening strata, they project higher above the general surface. When the molten overflow, represented now by the unconformable green chloritic schists, buried them in its progress, it carried along fragments of each a short distance toward the south. This eruptive rock must have been several hundred feet in thickness, since these points are now on some of the elevated

parts of the country, and its disintegration and removal must have involved not only a great mass of rock but a great interval of time. At points further east, however, the apparent continuation of this igneous rock, is more evidently of eruptive origin and exists in greater volume.

At the Breitung mine the involved schist is sometimes nearly white, and has a curving, fine basaltic or columnar structure, much slickensided, the columns being but two or three inches in diameter. In some places it is highly permeated with hematite, and might be called a soft ore. At short distances it varies to a fragile, greenish, more typical form, like that already mentioned at the west end of the south ridge, embracing large detached masses of quartzyte. At the Breitung mine it runs deep alongside the ore, at least as far as the mine has penetrated. It seems as if the distinction between the supposed igneous non-conformable greenish schist, and that which is interbedded with the ore, in successive alternations with it in beds of various thickness, is very difficult in some places to make out. It is yet necessary to ascertain what mineralogical, or what physical characters may be diagnostic of one or the other. Sufficient time has not been afforded for this determination, since these notes were made. Rock sample 884.

South from Tower. Messrs. Jones and Grant made a trip into the country, and Mr. Jones gave the following report:

"July 2, 1886. At a distance of $\frac{1}{2}$ or $\frac{3}{4}$ mile from Tower we found a range of low, irregular and rocky hills with a trend nearly east and west. After traveling a little further to the south, until we had reached about the highest portion of the ridge, this hight being probably from 40 to 50 feet, we turned eastward, and a little northward. At this point the rock appeared to be a somewhat massive graywacke, showing but little of the quite common schistose structure except on much-weathered surfaces; but as we passed to the eastward the rock seemed to graduate into a very schistose form, having a sericitic aspect. At a point in sec. 5, 61-5, about $\frac{1}{3}$ mile from the S. E. corner of the section, northwesterly, we found a cut made by the Duluth & Iron Range railroad through one of these hills. The cut was about thirteen feet deep and a hundred and ten feet long. At the northern end of the cut the rock has a sericitic aspect, of which No. 885 is a specimen, while at the southern end of the cut the rock has more the appearance of a graywacke. The dip we found to be 55 degrees north. Of this, rock 886 is a sample. The strike

is east, 10 degrees north. The rock, as a whole, contains a considerable amount of pyrite and much quartz in irregular veins. For about half a mile, following the ridge toward the east, the same rock appears, with very slight exceptions; and following the railroad toward the south numerous similar outcrops occur for about half a mile. Then comes a considerable amount of drift; and along the track in the S. W. ¼ of the N. E. ¼ of sec. 8, there is a cut 1,200 feet long and 12–14 feet deep, through a bed of gravel and sand; and in the S. E. ¼ of sec. 8 there occurs a cut 18 feet deep and 500 feet long. Of this cut about 12 feet was of rock and 6 feet of drift. This rock was of similar nature to that of the former cut, except being at times more massive, and jointed like a basaltic rock, and at times also more slaty. The dip here we found to be about 45° toward the north, with a variable strike. Specimens 887 and 888 are from this cut.

"The hills for half a mile east, at least, are of similar nature; and numerous outcrops from this point to, say one-third mile south, in N. E. ¼ of sec. 17 are of the same. In fact rocks of no other kind than a schistose, or massive, or a slaty graywacke, approaching at times a sericitic schist, were seen."

Mr. Stacy visited the low hills southeast of Tower, on S. E. ¼ sec. 33, just across the river, and found a succession of ranges running S. S. W., and not in parallelism with the jaspilyte range at the mines, terminating in spur-like projections near the railroad. He examined two of these and found they consisted of graywacke and argillyte, but with a much broken and confused interstratification, the two rocks being in a coarse breccia and sometimes changed to a poroditic rock, like No. 1 (H), which cuts obliquely and directly across the other beds, acting like an igenous rock. In this porodyte, which spreads irregularly, are some pebbles of graywacke, and some other syenite-appearing rocks. At another point he found greenstone dikes cutting the graywacke, varying from 18 inches to two or three feet, and widening out abruptly to eight feet across.

Sample 913 represents the rock seen in the following Fig. 27 as sketched by Mr. Stacy.

Sample 914 represents the rock seen in Fig. 28, sketched by Mr. Stacy.

Sample 915 represents the rock seen in Figs. 29 and 30.

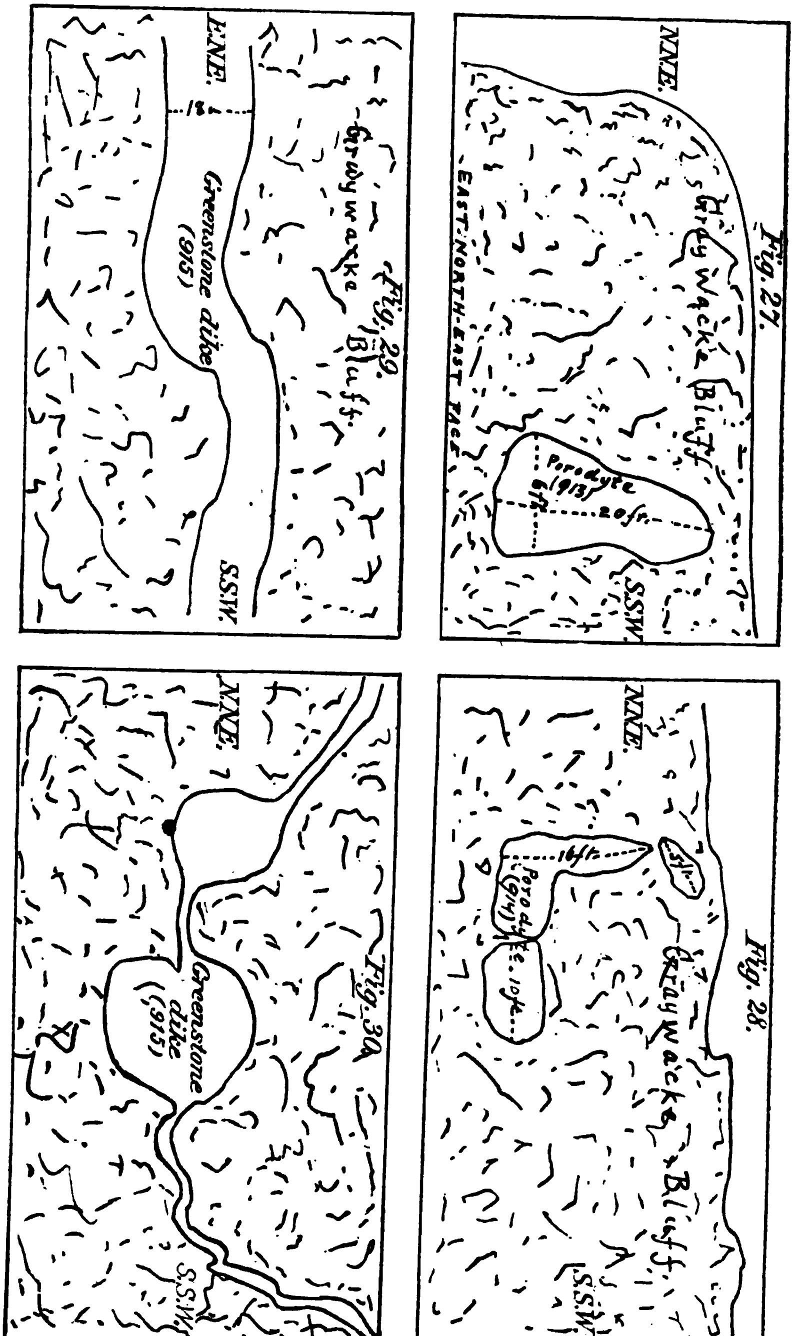
In Fig. 27 the schistose structure runs approximately east and west. The graywacke contains fragments and crumpled and broken beds of argillyte, making a continuous mesh or breccia.

Fig. 27 represents a bluff of graywacke rising about 80 feet high, having the same indistinct schistose structure. It is intersected by irregular and

crumpled meshes of argillyte bedding. The "porodyte" contains occasional graywacke and other pebbles.

The bluff seen in Fig. 29 has the same schistose structure. It consists of graywacke.

Fig. 30 shows the structure near the top of a bluff parallel to and connected with the bluffs seen in Figs. 27 and 28. The greenstone dike winds through a brecciated mesh of graywacke and argillyte. A schistose structure pervades this bluff parallel with that in the other figures.



 Figs. 27, 28, 29 and 30.

The geology of the "north ridge" is involved in the foregoing chapter relating to the iron ores of Minnesota. But few additional facts need be given. The ridge rises, as measured by aneroid barometer, 240 feet above Vermilion lake. The lake itself is 1,357 feet above average tide level. The ridge rises therefore nearly 1,600 feet above the sea. The principal iron deposit is situated near the central axis of the ridge and forms bare glaciated surfaces on the very highest portion. There is considerable drift on the southern slope, and the rock is hid so that no section continuous from the ore southward can be made out. On the north slope, while the rock is more frequently left uncovered, still there is no continued section. On the north side, at lower levels than the outcrops on the top of the ridge, the same kind of ore is seen in several places, forming conspicuous outcrops, beautifully banded. but running in diverse and unexpected directions, some of the exposed masses being large enough to indicate some value as merchantable ore. There are also large areas of conglomerate on the north slope, similar to that seen on Stuntz island.

At the west end this ridge is deflected northwestward, and, after a lower interval, reappears as an important ridge crossing the north side of sec. 28, and entering sec. 29. rising at this place, however, only about 150 feet above lake Vermilion. It here consists largely of jasper and quartzyte, and is associated with much graywacke and argillyte. The rock here almost uniformly dips from 80 to 85 degrees toward the north, but in some places, especially when it seems to show a connection with the main "north ridge" it exhibits a swinging change in dip through the west to the south, for a space of a few rods. But this is local. Some greenish, soft schist, like that seen in the south ridge north of Tower, and like some seen at the Breitung mine, appears in patches in the jasper and quartzyte, having a concordant structure resembling a dip and strike. But this is the structure that is super-imposed on the unconformable green schists of the region. North of this part of the north ridge are two recurrences of porodyte in alternation with patches of graywacke and one of clay slate or wackinitic slate, running in the same east and west direction. An immense boulder of the Stuntz island conglomerate lies on this part of the ridge, about on the N. E. ¼ of the N. W. ¼ of sec 28. This is 15 feet high and 24 feet long, and about 18 feet wide. lying directly on the edges of the quartzyte, and worthy of being photographed.

Rock No. 918 is from a large boulder near the Breitung mine. Several such were seen about Tower, and must have been somewhere in place not far to the north. The interesting point here is the change taking place in the hornblende crystals, viz., apparently a decay at the centre first, changing the mineral to chlorite (?), while a mere shell of pure hornblende remains. The rock appears to be a coarse quartz dioryte.

THE SHORES OF VERMILION LAKE.

Considerable time was given to a detailed inspection of the shores and islands of Vermilion lake, and some of the notes that follow were made by Mr. H. V. Winchell. His examinations embraced Ely island, the north side of Sucker point and northwesterly to and beyond Shonea island; and he assisted in nearly all other parts of the lake. Mr. Frank Stacy made some independent notes in the extreme western part of the lake, and in the northeastern. Some places were examined two or three times and by two or three different observers, often in company, in order that there might be a consistent and uniform understanding by all members of the survey, of the phenomena described by them, and the terms employed.

The description will begin with the place where the central camp of the survey was located, and will be continued toward the west and northwest round the lake to the starting point, though the order of examination was not in this direction, nor in any uniform course. The specimens were numbered serially as collected, and follow the order of examination chronologically. Those collected by H. V. Winchell are numbered independently, and are distinguished from other series by having the letter H in parenthetical lines following the arabic numerals.

Hoodoo point. This point is in the southern half of sec. 30, 62-15. The main camp was on the south shore, on the S. E. ¼ of sec. 30. The land is low, and was originally swampy, but the trees have been burnt off, and the surface is found to recede gently from the lake shore eastward, leaving a part which is dry throughout the year, facing the lake toward the west and southwest. It has a good clay soil and subsoil, but it is surrounded on the east by a swamp which is nearly impassable, separating it from the rocky ridge, about a mile distant, which rises between it and Tower. The clay, which rises about five feet above the lake at time of average water, is fine, gray and stoneless,

evidently deposited by the lake at some earlier time when it stood permanently higher than now. Owing to the prevalence of a gray till along the southwest side of Vermilion lake, governing the general contour of the land and the location of the present lake shore, it is probable that this clay is closely allied to that, though not stony, and derived from the gentle assorting action of the lake on the till at some stage in its history. Tests have not yet been made to ascertain whether this till, and hence this fine clay is of the western alkaline class, suitable for the manufacture of light colored brick, or is derived from the disruption and comminution of the crystalline rocks of the region, and thus suitable to make red brick, but geographic considerations rather favor the former. This clay must underlie all the southwestern shores of Vermilion lake where they are no higher than this, unless the stony till has preoccupied them. A sample is obtained for comparison with other similar clays in the state.

The bay between Hoodoo point and Hoodoo river is lined by a sandy beach, but near the base of the point is a low outcrop of graywacke and poroditic graywacke. There is another similar outcrop, nearly covered by boulders, at the picnic point at the mouth of East Two rivers.*

Beef bay. The point at the east side of sec. 36, 62-16, is one of boulders, but a little further west is a bold exposure of firm, fine-grained schistose schist, evidently siliceous but without evident free quartz, apparently a changed felsyte, or a porodyte in which the schistosity has been developed. The fibre runs 10° S. of W. and is perpendicular.

Boulders and drift materials hide the rock along the shore to the centre of the N. E. ¼ of sec. 3, 61-16, where a small point that projects northward exposes a low glaciated surface of hard schistose graywacke which is represented by No. 864. About a square rod of rock surface is visible. The schistose structure runs E. and W., and is not distinctly separable from the bedding structure. The rock is purplish-black.

The rock here is brecciated, and recemented by a poroditic rock (finely porphyritic) resembling No. 2 (H), but of a darker color, approaching the color of the rock of the breccia. In the midst of this cementing rock are pebbles, or fragments, of slate resembling the breccia, but the pebbles are elongated in the

*The aboriginal name translated "East Two rivers" should be abolished. It might be called Hoodoo river, for the same reason that Hoodoo is given to the point so designated, meaning the river that dupes or makes a fool of the canoe-man not perfectly familiar with the country.

direction of the schistose structure, and are porphyritic faintly with white crystals of a feldspar like those in the cementing rock.

On the S. E. ¼ of the N. E. ¼ of sec. 3, 61-16, about forty-five feet above the lake, at the site of the old town of Winston, the cementing rock last mentioned rises in a bare smooth dome. It is here massive, weathering whitish, showing no visible sedimentary structure, nor evident schistose structure—though there is in some places an apparent short, coarse striation that runs about E. and W. It is cut by numerous joints, some of them such that if the rock were to be disintegrated it is likely that a so-called basaltic structure would become apparent, similar to that in the trap rock at Taylor's Falls. There is no uniformity in the direction of any system of this jointage, but, taken altogether, there is a prevailing distinctness in those lines that vary from N. 10° E. to N. 10° W. This rock contains abundance of free quartz in small grains, but not so large as in No. 1 (H). Some of the feldspar grains are angular, but very fine. This rock might be styled graywacke, but there is no trace of any original bedding, which is the usual accompaniment of graywacke. The color within is greenish-gray. There is a close alliance in all features that are outwardly distinguishable, between this rock and the felsitic conglomerate seen in Stuntz island.

At the mouth of Pike river, which enters at the extremity of Jones bay, in the western part of sec. 3, T. 61-16, on the right bank, at twenty feet above the water, the outcropping rock shows a sedimentary structure running about E. and W., coincident with an imperfect schistose structure, the dip being S. 80° from the horizon. This is nearly a typical graywacke, but it embraces beds that are more massive, with fine disseminated quartz, and resembling some of the felsytes. This dip does not prevail far but is replaced by structures running in various directions, and separated by faults. In one place a coarse granitoid rock, like No. 1 (H), constituting a bald, prominent elevation, occurs suddenly as if eruptive. The relations are obscured by the prevalent drift.

At the falls of Pike river the rock shows plainly, and nearly everywhere, a bedded sedimentary structure, crossed by faults that cause jogs of a few inches, or even a foot. The following sketch was made here in 1878:

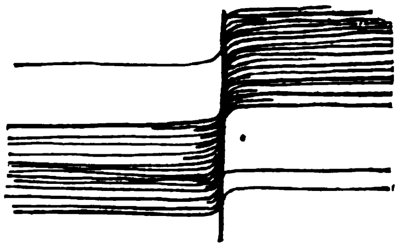


Fig. 31.—*Showing a fault in the graywacke at the falls of Pike river.*

What is significant and important here is the interstratification of rock much like the massive graywacke seen at the old site at Winston, containing fine grains of quartz, in layers repeated many times, from one inch to four inches in thickness, with the darker, slaty graywacke. Some of these bluish-gray layers, which weather lighter colored than any of the rest, are evidently quartzytes with but little feldspathic matter, but some are quartz-felsytes or porodytes, and are like some of the beds that show in some places, many evidences of being of igneous origin. This bedding runs 10° N. of E. and dips 80° south, 10° E. There are some veins and segregations of white quartz, some of the latter coincident with the bedding.

The head of the bay is marshy, but there are low hills at a short distance from the shore.

On the point near the S. W. ¼ of sec. 34, 62-16, is a gray quartzyte, represented by rock 865. This shows a very evident sedimentary banding. It has a slight exposure on the north side of the point, and while standing nearly vertical, like the graywacke near the mouth of Pike river, yet dips N. 85°, (25° E.) from the horizon. Toward the north it varies to a graywacke slate with concordant stratification, and toward the south it varies to a porodyte, the latter showing the same evident sedimentary structure.

The next point toward the east, in sec. 34, 62-16, nearly north from the centre of the E. and W. line, is of porodyte, or quartzose graywacke, which has much feldspathic material. This is schistose in a direction coincident with a doubtful sedimentary structure, running E. 20° N. The dip is S. 85°—90°, 20° E.

There is considerable coarsely schistose rock seen at some of the points in the S. E. ¼ of sec. 34, 62-16. This weathers light colored, and seems to be of the nature of the felsitic rock of

Stuntz island, although such rock has been and will be in future descriptions provisionally included under the term sericitic schist.

The southwest end of the large island in sec. 35, 62-16, shows a schistose poroditic rock rising about 20 feet, rudely bedded in coincidence with the schistose direction, dipping S. 20° E, about 85° from the horizon. This bedding is perhaps not due to sedimentation, but is a variation in the composition which might be called more correctly foliation. It is crossed by jointage planes running in nearly all directions. This seems to be the continuation of the similar rock seen at the old town site of Winston.

The coast line along the north side of Beef bay is composed of drift materials, which continue easterly to the point near Whisky island, in the N. E. ¼ sec. 36, 62-16. This point contains graywacke rock at the extremity, but Whisky island consists of sericitic schist, on the north and west sides, and the rock of this island is hid otherwise by drift.

Sucker point. The coast line again consists of drift along the south side of Sucker point through sec. 25, 62-16, and sec. 30, 62-15; but round the shores of Sucker point in sec. 19, the underlying rock frequently appears, consisting of graywacke or felsitic rock that is intimately associated with graywacke.

On the south side, in the N. W. ¼ of the N. W. ¼ of sec. 30, 62-15, no rock except boulders can be seen. In the N. E. ¼ of the N. W. ¼ of the same section, the point rises up to 45 feet high, and a conglomeritic felsyte crops out, similar to that seen on Ely island. It is quite hard, being but little weathered, and is full of pebbles, some being of graywacke, and some like the ground-mass of the rock itself. The schistose structure is E. and W., with no ascertainable dip. On the S. W. ¼ of the S.E. ¼ of sec. 19 the schistose structure runs 10° S. of E. A small island here is made of this rock. It is about 20 feet across and four feet high. On the north side the rock appears to be what could be styled felsyte, but toward the south it seems to grow more and more fine-grained and to turn into graywacke within twenty feet. Both have here the same schistose structure, and both have a basaltic structure. This is Kego or Fish island.

On the point, northeast of the island (S.W. ¼ of the S.E. ¼ sec. 19), the two kinds of rock grade into each other even more than they do on the island. In the S. E. ¼ of the S. E. ¼ of sec. 19, on the point, the felsyte and graywacke come together again. There is an indistinct line between them, on the surface, not discern-

ible when broken or on a fresh surface. The felsyte contains pebbles of the other, and small cubes of pyrites. The graywacke dips south (?) and contains large cubes of pyrites. A common schistose structure pervades both. A little further on, the dip is plainly toward the north.

The point in the north half of the S. E. ¼ of sec. 19 is low, and almost covered with boulders, specially round the north side, some of them being at least fifteen feet in diameter.

On the north side of the point, in the S. W. ¼ of sec. 19, the rock resembles felsyte, as here designated, though it has a greenish color, frequently weathering nearly white. It here seems to have a bedding running 30° S. of E., while the schistose structure is E. and W. This is the first place seen in which a bedded structure appears in a rock that resembles felsyte more than graywacke. In the bay S. W. ¼ of sec. 19, the felsyte turns green, and resembles No. 3 (H).

On the small island, north of the point, in the S. E. ¼ of sec. 23, 62-16, the rock is a sericitic schist or dioryte. It is greenish and resembles No. 2 (H.), but is finer grained, with an east and west schistose structure, merging into the graywacke on the south. The rock shows various colors from green to brown or red, and contains some quartz and pyrites. The line of separation of these two rocks is hard to find. The bedding of the graywacke is somewhat disturbed and broken near the place where the two come together, but has a general directon 35° S. of E. Part of the supposed dioryte seems to have a bedding parallel to that of the graywacke. There are veins of quartz, an inch in thickness, and larger masses of jaspery rock, more or less changed, contained in the dioryte.

Near the centre of sec. 26, 62-16, is a low exposure of black slate containing veins of quartz. The structure in some places is somewhat distorted, but in others very smooth and straight. The bedding and schistose structure run S. 6° E.

In the S. W. ¼ of the N. W. ¼ sec. 26, is a large mass of greenish black slate or slaty schist, with a schistosity running 10° S. of W., and a bedding 14° S. of E., the former having numerous siliceous veins, and some veins of pure quartz, running parallel with it. At this place, twenty years ago, a shaft was put in, and considerable work was done, the depth of 35 feet having been reached, wholly in the dark slate. Several log houses were put up, but the place has all been abandoned. The dip of this rock is slightly toward the north. On the surface, near the lake, the

rock does not appear so slaty, but is more like a fine-grained graywacke and has very distinct bedding. The north side of each stratum has the schistose structure obscure, but the sedimentation very plain. The strata vary from six inches to a foot or more in thickness. The shore line thence through secs. 23, 22 and 16 consists of drift, without rock exposure, rising from ten to forty feet at a short distance inland.

Birch point. Near the east line of sec. 16, 62-16, is a small exposure of slate on the south shore. The whole of this point, in sec. 16, is probably closely underlain by rock, but it is hid by drift.

The island which is crossed by the line between secs. 15 and 16, 62-16, is mostly composed of a gray, poroditic or sericitic schist. It is hard, tough, compact and almost massive. It has pyrites, more or less disintegrated, all through it, giving part of it a greenish look. The schistose structure is obscure, but seems to trend E. and W. The island rises about twenty-five feet. Rock No. 4 (H).

This point, further east, rises from 30 to 50 feet above the lake, but consists of drift. Only boulders are seen on the beach, throughout secs. 15, 11, and to the S. W. ¼ of sec. 10. The island off the point, near the centre of sec. 11, has an underlying rock-structure of sericitic schist.

The island north of Birch point, in the S. W. ¼ of sec 10, shows an outcrop of sericitic slate running E. and W. with a slight dip to the north. West of the slate, on the south side of the island, the rock is more schistose, and less slaty.

On the N. W. ¼ of sec. 16, 62-16, on the north side of Birch point, is a low exposure of greenish sericitic slate. The bedding and schistose structure coincide, and run E. and W. The dip is apparently to the north, though not so plainly, nor so much, as on the small islands in the S. E. ¼ of sec. 9, 62-16. There are numerous small veins of quartz in the rock, running parallel with the schistose structure. The rock is not a good slate, but the bedding is so straight and regular that it splits into slaty slabs and fragments in some places. In others it is simply a schist.

One of the small islands in S. E. ¼ of sec. 9 is composed of a somewhat slaty greenish sericitic schist, with its structure running E. and W. It is full of pyrites cubes, up to ¾ inch in diameter. The dip is slightly to the north. The island rises eight or ten feet out of the water.

At the corner post of secs. 7, 8, 17 and 18, 63-16, is found a green schist (5 H), even-grained and moderately firm. It rises but two or three feet above the water, and is soon concealed by drift. The dip is not apparent. There is no perceptible bedding, and the schistose structure seems to run E. and W., although it is not very marked. This rock has a basaltic jointage suggestive of an eruptive origin. On the north side of the bay, in the S. E. ¼ of sec. 7, 62-16, is a massive, syenite-looking rock, grayish-red to greenish in color (6 H), rising about ten feet above the water in rough, bold crags or hillocks. It has no evidence of metamorphism nor of sedimentation. There are seen a few masses of chlorite-like material, but the most of the rock is homogeneous, apparently containing orthoclase, quartz and hornblende or chlorite, and a little pyrite. The rock has the general appearance of having an eruptive origin.

Black Duck point. Further east, in the S. W. ¼ of sec. 8, 62-16, there is a low exposure of graywacke, and east of this, about the middle of the section, the syenitic rock again crops out. The hills are covered with drift, and heavily wooded, so it is not possible to see where this rock and the graywacke come in contact.

At the S. E. ¼ sec. 8, 62-16, is a siliceous schist which seems well adapted for whetstones. It is fine-grained and evenly sheeted. It runs E. and W., rising but ten feet above the water. It contains small particles of a dark greenish mineral that become rusty and red near the surface. There is a slight dip to the north. (7 H.)

A conglomeritic rock outcrops at the same place; this is rather fine-pebbly, with feldspar and quartz pebbles or crystals. The color varies from reddish to greenish, the pebbly structure being more evident near the surface than further in. There seems to be an east and west schistose structure, the matrix being apparently a sericitic schist. The connection between this and the last can not be discovered, as it is covered by drift and the water of the lake.

Some mining has been done on the N. W. ¼ of sec. 9, 62-16, in rock that resembles 7 H. It here appears to be eruptive, and in dikes through the graywacke. On the south side of what may be a dike the dip is toward the south, and on the north side it apparently dips north. There are some small veins of quartz.

These have been followed, in the mining, thirty feet or more. East of here the hill appears to be composed chiefly of a green rock, like trap. (9 H). It has come up in the sericitic schist,

and thrown it over till it lies almost horizontal, with a slight dip to the north. It has the general form of a dike running across the sericitic schist diagonally from S. E. to N. W., but this is not certainly the structure. The hill in which it is found rises 90 feet above the lake, and is heavily wooded. Some syenitic rock is also found here.

On the point, S. W. ¼ of the N. W. ¼ of sec. 10, rock No. 9 (H), has a large exposure. Here it seems to almost have a structure in the direction of that of the graywacke. It is low, and has a basaltic jointage. On the next point bedded graywacke is seen running E. and W. Here it is evident that the doleryte No. 9 (H), runs in the same direction as the regular graywacke, and near their junction contains pieces of it. It looks more than ever as if No. 9 (H) were a changed condition of the graywacke, and not eruptive.

Graywacke forms the small rounded island in the S. E. ¼ of the N. W. ¼ of sec. 10. In this are small dikes running nearly, but not quite, parallel with the schistose structure; but about 10° to 18° N. of E., while the graywacke runs E. and W. The rock in these small dikes (two inches thick) resembles No. 9 (H).

The large island off the end of Black Duck point, crossed by the line between secs. 3 and 10, rises from thirty to fifty feet above the lake and consists of a rock sub-structure of graywacke varying to a greenish schist, dipping to the north, considerably obscured by drift.

In the S. W. ¼ of sec. 33, 63-16, are outcrops of rock ten or more feet above the water, that are greenish, and have the massive structure and basaltic jointage of eruptive rock. They show no sedimentary structure, and but feebly a coarse schistose cleavage. There is no apparent dip.

On the west side of Black Duck point, S. E. ¼ of sec. 5, 62-16, are seen dikes of rock resembling No. 2 (H), running through the graywacke or sericitic schist, in a direction that varies from 10° to 20° north of east. This rock stands unconformably by the side of, and in, the schist, and incloses many large masses of the same. The rock of these dikes is quite homogeneous, and does not contain, apparently, any pebbles, such as seen in No. 2 (H). The dikes vary from 3 feet to 6 feet in width. Rock No. 10 (H).

No. 11 (H) is from a dike running through the graywacke in the S. E. ¼, S. E. ¼ sec. 5, 62-16. It is a tough, grayish green rock containing considerable hornblende. It is also pyritiferous,

and has veins of quartz running through it, and scattered nodules of syenitic rock, but no free quartz in the rock itself. It contains black mica and exhibits a coarse schistose structure. The dike runs parallel with the bedding of the graywacke, while the schistose structure of the graywacke is 20° N. of E. In secs. 5, on both sides of the bay, graywacke is the underlying rock and is considerably disturbed by dikes, sometimes appearing twisted almost as badly as the bands in the jasper in T. 62-15.

Argillaceous schist which approaches slate in hardness and firmness of grain, appears in the S. E. ¼ of sec. 6, 62-16. It forms a knoll, and runs 50° E. of N., dipping S. Coincident with the schistose structure are numerous small quartz veins. A little further west the rock is about the same, but seems to be mixed with lumps of harder more siliceous rock of a pinkish color and fine texture. In the N. E. ¼, S. E. ¼ sec. 6, 62 16, this argillitic rock runs 10° S. of E. It is quite hard, and only a little of it is exposed. There is a considerable amount of the harder pink rock in it.

In the S. W. ¼ of sec. 6, 62-16, is seen a heavy fine-grained schist. Running through it is seen a considerable amount of some fine-grained feldspar, resembling orthoclase in color. There also appears to be some mica in some portions of the schist, and pyrite in nearly all. In one place a bed or stratum was seen that apparently contained hematite. There is an evident bedding, or foliation, dipping a little to the west of south. In the southern part of sec. 7, T. 62-16, are seen hills that rise about 100 feet above the lake.

In the S. W. ¼ of sec. 6, near the town line, is an exposure of greenish schist, approaching graywacke, which has been filled with crystals of pyrite, but they have weathered out and the rock has somewhat the appearance of an amygdaloid. Near the town-line, N. W. ¼ sec. 7, 62-16, is an outcrop of a heavy, massive, greenish black dioryte, which probably is in a dike, though the boundaries of it can not be ascertained. It contains mica, hornblende (passing to chlorite) and feldspar. It extends for 100 feet or more. No. 15 (H).

On the south side of this dike, or at least just south of it, is a large dike, or bed, of porphyritic feldspar rock No. 16 (H). This rises 20 feet in a bold knob. The crystals of triclinic (?) feldspar, half an inch long, stand out thickly all over the weathered surface. There is some quartz in the rock, and there appears also to be hornblende. The connection between this and the rock

on either side is covered. There is a quartz vein a foot or more thick running through it 50° E. of N. These two rocks, 15 (H) and 16 (H), alternate several times along here, but are not seen in contact so as to disclose their relations.

Birch bay. In the S. E. ¼ of sec. 1, 62-17, the outcropping rock is a greenish sericitic slate containing much pyrites. This rises but a foot or two above the water, and has a schistose structure running 10° N. of E. The dip is toward the south. On a small point a little west of the last, the rock is still a greenish sericitic slate. The bedding is wavy, and runs in a general E. and W. direction, while the schistose structure crosses it in a direction 10° N. of E. There is a small fault across the bedding which is of later date than a short vein of quartz, for it runs through the quartz and has carried part of it six inches toward the northeast from the rest of it.

The small island east of the point in the S. E. ¼ of sec 1, 62-17, is a very nicely exposed knoll of greenish sericitic schist. It has a very plain bedding structure running 20° N. of E. and a schistose structure not so plain running (40°?) E. of N. It is slaty in some places, but generally is too soft to be called slate. The bedding lines are bent or curved somewhat in all directions. There are numerous short veins of quartz, up to a foot or more in thickness, running principally in the direction of the bedding.

On the point in the S. W. ¼ of the S. E. ¼ sec. 1, 62-17, there is a greenish siliceous (?) schist (17 H) that has but faint bedding, nearly vertical, and basaltic jointage. It rises immediately out of the lake, ten feet or more, and is considerably broken up. This rock is about the same as 14 (H).

About the N. E. ¼ of the N. E. ¼ of sec. 12, No. 16 (H) appears again, in the same bold, high fashion as on the other side of the point. Here it seems to come up through sericitic schist on its south side, and probably the same on its northern side. A little further southwest is a large high bluff of rock considerably like 16 (H), and also like 12 A (H). It extends along the shore of the lake for two hundred feet or more, rising 20 feet above the water.

South of this is rock like No. 14 (H), only a little redder. It has basaltic jointage and a kind of bedding. It dips a little to the south, and extends 50—100 feet; still further south rock like Nos. 12 A (H) and 16 (H) returns for forty or fifty feet.

South of this is a clay slate with schistose structure running a

little E. of N. Then comes a harder, firmer slate-like rock, except that it lacks the even bedding of slate. This rock grades into sericitic schist, which continues, more or less firm, until it passes into a sort of semi-crystalline rock which has a coarse schistose structure running about 40° E. of N. The hight of the hill, here, has diminished to four or five feet.

On the small island on the S. E. ¼ of the N. E. ¼ of sec. 11, 62-17, there is a small point about five feet above the water, composed of hard greenish rock, with no plain bedding. It has a schistose structure running 40° S. of E. There is a lining, which may be due to a sedimentary bedding, running in about the same direction. Rock 18 (H).

On the south side of the island in the N. E. ¼ of sec. 11, 62-17, is a striped red and green schist, standing nearly vertical. The bedding is much disturbed, but runs about 30° S. of E. Dip is N. rather than S. On the N. W. end of the same island there is a low outcrop of dark green, hard, fine-grained, hydro-mica schist. It has bedding running 10° S. of E. and a schistose structure running 30° N. of E. There are many small veins of quartz running in the direction of the bedding. Boulders are very numerous at the west end of the island, and cover the rock almost wholly.

The coast line then is one of drift and boulders as far as the N. ½ of the S. W. ¼ of sec. 3, 62-17, when hills of mica-schist rise, near the coast, to the hight of ninety to a hundred feet. The first rock seen, in coming up along the shore from sec. 10, is the greenish sericitic schist so abundant east of here in this bay. This has a schistose structure running 60° E. of N. Out of this rises a hard, tough, pinkish-green, crystalline rock, whether syenite or dioryte is hard to say. It is chiefly composed of feldspar and hornblende, with a greenish mineral besides, and some pyrite. It is hard and massive, and it makes a great ridge. It is No. 19 (H). It is not more than 20 or 30 feet wide, and on the east and north mica-schist appears. Along the coast these two rocks alternate, the mica-schist occupying lower levels than the syenite; but the schist is also very hard, and almost massive, with a schistosity, or foliation, running 20° N. of E. The high hills in the north half of sec. 3, along the shore, run in the direction of the trend of these rocks, and are caused by them, the summits of the principal alternating ridges being composed of rock No. 19 (H). The alternating rocks occur in belts or beds that vary in thickness from ten or twelve feet to forty or fifty feet.

In the N. E. ¼ of sec. 3, 62-17, can be seen a dike of red syenite, about six inches wide, running through the rock No. 19 (H), about east and west. It is faulted off in one place, about eight inches. This is represented by 19 A (H).

In the N. E. ¼ of the N. E. ¼, sec. 3, is a dike of pinkish syenite running through the schist 50° S. of E., while the schistose structure is 30° N. of E. This dike is much like 19 A (H), but is a little coarser, and not quite so pink.

On the W. side of the island, in the N. E. ¼ of the N. W. ¼ of sec. 2, 62-17, is a large dike of No. 19 (H), running about 30° north of east. It contains some few narrow crooked veins, or beds, of mica-schist. There are also in it dikes of the light white to pink syenite which go in all directions through the greenish dike.

On the south side of the small island in the centre of sec. 2, is a bed or dike of pink rock, almost wholly of feldspar, coming through a hydro-mica-schist. It is not very hard but is particularly decomposed into angular pieces of various sizes. It is a schist, and grades into a hydro-mica-schist, in almost imperceptible degrees. This is rock No. 20 (H).

On the small island 25 feet across, in the S. E. ¼ of sec. 35, 63-17, is a felsitic conglomerate, or porodyte. It has a schistose structure running E. and W. The island rises less than two feet out of the water, and is composed entirely of this rock. It has a matrix of apparently sericitic schist, and there are in it pebbles of quartz of all sizes and shapes up to three inches in diameter. The structure is bent and doubled considerably, and there is no certainty of any bedding structure.

Birch river and Avis island. The little islands that lie south of Avis island, forming the canoe and the steamboat channels from the upper lake, are composed of mica-schist, variously cut by and mingled with dikes of two other rocks.

On a little island near the centre of sec. 36, 63-17, in the north part of the "canoe passage," the rock is mica schist. There are visible on it, however, no real dikes that cross the bedding, though they are visible on the larger island next west. The surface of the rock on this little island is ridged by unequal erosion and decay in weathering. The ridges are prevailingly in several pronounced directions. First, are those that coincide with the bedding structure. These consist of variations in the rock itself and of quartz. The quartz is chemically deposited and did not exist at first as part of the bedded rock. It is vit-

reously crystalline, and about white. The others are micaceous quartzyte, sometimes being dark like the mica-schist and sometimes gray, or nearly white quartzyte. These both show, on their flat surfaces, wherever the mica-schist has been removed by weathering, a striated appearance, resembling glacial marking, that runs at an angle with the horizon, of about 40°, descending toward the west. This striation, however, is due to the internal variations in the hard rock, and becomes visible only on the removal of the softer rock. The second kind of ridges crosses the first at about a right angle; and they are so frequent and abundant as almost to produce a schistosity in that direction. They dip toward the N. E. at an angle of about 45°. Their cause is apparent. On the weathered, upper edge of each one of them, or many of them, can be seen an open fine fissure splitting the ridge longitudinally into two parts, the hardened schist being hardest just at the plane of contact of the two halves, so that the fissure really splits the edge of the ridge. The bedding, and a kind of foliation or gneissic structure coincident with the bedding, is not disturbed by these ridges, but the mica scales, etc., are elongated E. and W. instead of N. and S. This hardening of the schist on either side of these minute fissures is due, apparently, to the action of gases and chemical secretions on the adjacent rock walls. Such would gather in the fissures, and in all passage-ways, more readily than elsewhere, whenever upheaval, or any disturbance, should produce the openings. The third kind of ridges passes irregularly and confusedly across the surface of the mica-schist, but they consist, like the last, of hardened belts in the mica schist. They are less conspicuous than either of the last, and less frequent; but they are sometimes broader — ½ inch to 3 inches. The first and second kinds vary from the faintest linear elevation to ½ inch or 1 inch across.

The plat sketch, represented by fig. 32, was taken from the glaciated rock-surface in a little bay on the northeast end of Menan island, not far from the centre of sec. 36, 63-17. The shaded portion, representing mica-schist, the main rock of the country, is shown to have been broken first by some force and cemented by some very quartzose syenite. Subsequently these were both fractured and the opening was filled by the greenstone dike. Neither the syenite nor the greenstone is conformable with the strike of the mica-schist, which is 35° E. of N., although they seem to run, in general, in the same direction. The greenstone dike is amygdaloidal, but the amygdules appear now to

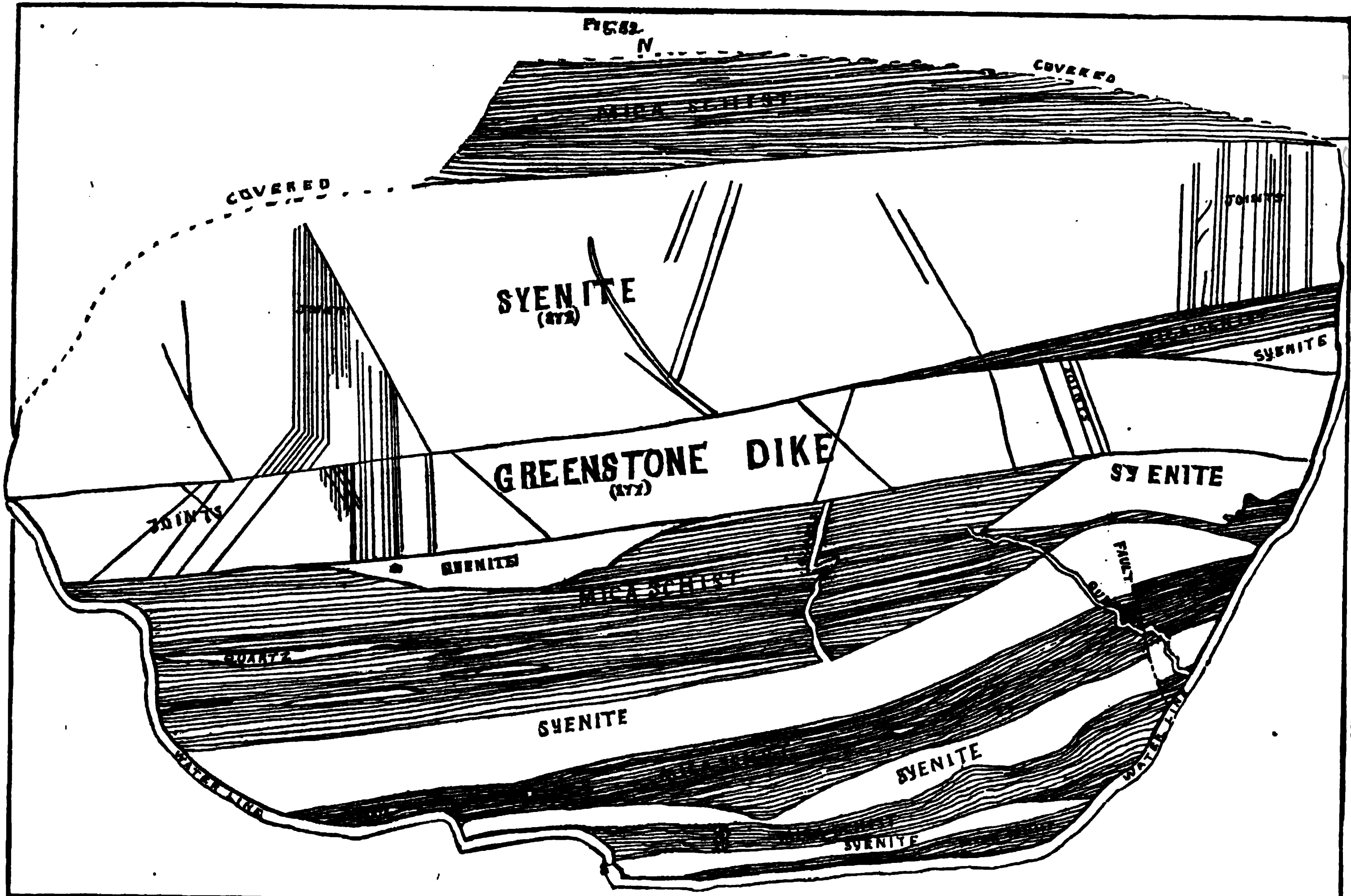


Fig. 32.—Showing the alternation of syenite and mica-schist, and an unconformable greenstone dike [illegible]

be wholly of fibrous hornblende. This structure is not visible throughout it, but is so in nearly all parts of it. The rock consists mainly of hornblende and a triclinic feldspar, making a dioryte. Rock samples 877 and 878.

On the northern slopes of this island, northwest of the point sketched, are other greenstone dikes, and irregular areas of syenite, one of the dikes of greenstone being about eighty feet wide, running in the same direction. The island rises 10 to 15 feet.

At numerous places on and about Avis island, rock like No. 878 (syenite) is seen crossing the mica-schist in diverse directions in the manner of dikes, some of them being nearly horizontal. In some small areas and knobs, nothing can be seen but the syenite, in other places small areas of mica-schist appear, more or less inclosed by syenite. The dip is uniformly preserved toward the south, 25° — 35° east. On the south side of the island, hills of this kind of rock rise about fifty feet above the lake, but in general the rock is covered by drift deposits. Toward the north the syenite increases in amount, compared to the mica-schist.

At the clearing for a cabin, near the S. W. corner of sec. 25, 63-17., on Avis island, are large exposures of mica-schist dipping south, but nearly vertical, veined with syenite and quartz, and crossed by fine seams and ridges. This is at about thirty feet above the lake.

In the north part of sec. 36, 63-17, on the island, the same rock as the last appears, standing conspicuously, nearly vertical, but dipping in one place toward the south, and at another toward the N. W. It is cut by frequent dikes of syenite. This N. W. dip, so-called, is illusory, due to a system of joints that cross the formation.

On the N. W. ¼ of sec. 36, 63-17, the syenitic rock prevails at several points on the coast, but includes angular pieces of mica schist, as shown by Fig. 33. In some places the schist prevails

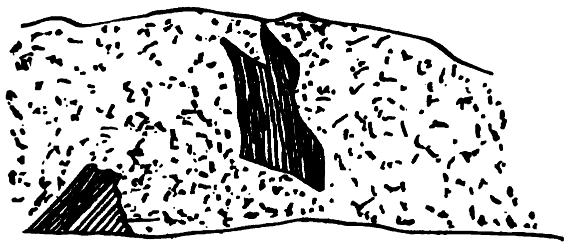


Fig. 33.—*Showing angular pieces of mica-schist included in syenitic rock on Avis island.*

and is simply cut by dikes of the light-colored rock, the dikes being of irregular shape and not constant in direction, but prevailingly conformable with the strike of the schist, which is about E. and W., or rather somewhat S. W.

Samples No. 923 show the manner of contact of the mica-schist with the syenite, obtained near the centre of sec. 35, 63-17, at the southwest corner of Avis island.

The dip on Avis island, along the southern shore, seems to be generally to the south, but this observation is unsatisfactory on account of the broken conditions of the schist. In the little channel west of the island it is more plainly seen, and is unmistakably toward the south. Mr. Stacy, who examined the west side of this channel, in sec. 35, obtained near the S. W. ¼ of the section, rock sample No. 924, which is a real granite. He also found sample No. 925, which appears in the midst of the granite in a manner similar to that of the mica-schist, but has the general aspect of graywacke. It is a very fine-grained mica-schist.

Outlet bay. This name is here given* for convenience of reference and description, to the bay from which Vermilion river flows, including its extension southwestward through the central part of T. 63-17.

Along the N. E. ¼ of sec. 23, 63-17, where the rock is not hid by boulders, it dips N. 20° E., this being a change of 135° from what it is further south. The granitic rock in it is not so prevalent as when the dip is south; still it holds scattered small veins, and irregularly shaped nests of the same kind of rock. The amount of the dip is about 40°, and is quite plain.

In the southern part of sec. 13, 63-17, on the shore-line running N. and S., is a mixed rock, made up of confused and broken masses of mica-schist with its foliation more or less obliterated, dikes — mainly narrow — of the usual syenite, and white quartz. The direction of the main strike, if there be one, can not be made out, owing to the brecciated and confused condition of the rock. Some areas of rock that resemble mica-schist, are a fine gneiss, or a gray micaceous quartzyte.

In the northern part of sec. 13, 63-17, are some other confused outcrops. The mica-schist becomes converted to a hard, dark-colored rock, with only a gneissic foliation, or with no foliation. Boulders containing both these kinds, evidently from the formation not far away, are seen frequently on the shore. The shore line mainly is of boulders. In one place the dip of the mica-

* It was first applied in the report for 1880, p. 100.

schist, with its embraced syenite, seemed to be changed again to a southerly direction.

In the S. E. ¼ of sec. 11, 63-17, is an exposure of syenite and mica-schist, the former making the larger part of the mass. It stops up irregularly from the water, the entangled mica-schist dipping N. W. at an angle of 40° from the horizon.

At the outlet of Vermilion lake, which is near the north line of sec. 11, 63-17, there is no rock exposed plainly above the surface, nor is there for some distance toward the south. On the east side of the narrow bay that leads to the outlet, about a quarter of a mile from the beginning of the rapids, is a knob or boulder-like prominence, about twenty feet long and perhaps ten feet high, whether rock in place or not I am not sure, which consists of syenite and hard mica-schist, or dark gneiss, similar to much that is seen along the same coast-line further south, on the border of transition from the foliated, supposed sedimentary, to the massive and possibly eruptive. Along the rapids the water tumbles over boulders, mainly of syenite with a few of the other massive crystalline rocks. In 1878 I concluded that the underlying rock in the rapids is mica-schist, having seen numerous fresh pieces in the channel. On the portage trail, which is on the east side, some large boulders are seen, forming low elevations that otherwise perhaps contain rock in place, but no outcrops are visible throughout the distance passed on the trail.

The country is drift-covered and wooded, largely with pine but also some aspen, some oak, occasionally an elm, spruce, balsam, ash, and soft maple.

It is more than probable that the underlying rock, at the commencement of the rapids, is a "granite" or syenite, mingled with angular fragments, and large masses, of mica-schist. Such rock makes the most of the boulders, and some slabs of more or less interbedded, freshly ruptured (i. e. not rounded) mica-schist, near the upper landing, and on a "point" on the west side, as well as at points already noted, serve to confirm this. Again, not far from the outlet, on the west side, rock which is apparently *in situ* can be seen under the water, though in the forms of angular slabs.

Further south, on the west side, near the east half-section line, in sec. 11, 63-17, rock appears to be *in situ*, though consisting of an isolated knob or tongue, rising abruptly from the water, and extending not more than twenty feet. This consists of syenite and mica-schist, the former making more than one-half of it all. The average dip is N. or N. N. E.

At the S. W. ¼ of sec. 11, 63-17, on the south side of the bay from the last, is a good exposure of the same rock. It is made up of mica-schist and syenite or granite. It rises, inland, and reaches the hight of 30 feet, more or less, at a few rods from the point. It is difficult to make out the strike or dip, owing to the confused mixture of the two rocks. Yet the direction of the little tongue of rock (as well as at the last point noted) which shows a prevailing trend E. and W. and a distinct dip in some places to the north, to the amount of 50° from the horizon, all indicate a north dip for the formation here.

On the north end of the island, at the section line between secs. 11 and 14, 63-17, the rock is prevailingly mica-schist, but it is mingled with the same light-colored syenitic rock. If there be any dip at this place, it is toward the south, as there is an elongation of structure east and west, with interleaved veins of granite dipping in that direction. A little further west, however, and south, on the same island, at a knob of a point, the rock is so confusingly mixed that no structure can be determined. The same is true also at the next little point on the same island, the rock being almost entirely of syenite.

On the point near the centre of sec. 14, 63-17, the rock is partly a breccia. This round point has three exposures; the northern one is this breccia, with no direction of dip or strike. At the next, toward the south, the rock is gneiss, or hard, closely jointed mica-schist, or micaceous quartzyte, with a strike E. and W., and nearly vertical, or dipping north. At the third the rock is evidently a bedded one, with little disturbance. It varies from a hard gneissic mica-schist to a fine, hard, almost flinty, gray, micaceous quartzyte, with a dip of 35 to 40 degrees toward the north. This is rock numbered 879. These exposures are all small, from 20 feet to 50 feet, along the beach, and do not show their relations to each other, by direct contact; but the dip seen in the last mentioned would indicate that it lies lower than the other two.

Still further south, about ¼ mile north of the south side of sec. 14, 63-17, is a sharp, rocky point, projecting east, made up of mica-schist and conformable layers of gneissic mica-schist, and some syenite dikes running in the same direction, all showing a very evident dip N. (exactly) of about 40 degrees from the horizon. In this are not only large conformable (or nearly conformable, layers, or dikes, of syenite, but also small isolated and lenticular nests or nodules, of syenite (No. 880). These latter

swell out so as to interfere with the foliation, which here is the bedding structure. It is very evident here that *a bedding structure is the cause of, and is converted into*, the foliation, producing a gneissic structure. Both can be seen in the same rock mass. This is the same as observations made elsewhere in this report.

Still again, at the section line between secs. 14 and 23, 63-17, the same rock, and the same dip can be seen abundantly displayed. But the dip here varies to 10° east of north. The dikes do not all conform to the bedding, but some times cut it zigzag. The bluffs here rise about thirty feet, and are all made apparently of this mica-schist.

Syenite, massive or only jointed, constitutes the coast from near the N. E. corner of sec. 22, 63-17, southwestwardly, as far as the southeast corner of sec. 29, except when hid by boulders, which latter is nearly two-thirds of the way. There can be seen nothing but boulders, on the shore, eastward from the Bear narrows, through secs. 32 and 33, 63-17, and to the S. W. ¼ of sec. 27, where the islands consist of mica-schist dipping south, 30° from the horizon. Northwestwardly, through the same section, boulders form the shore, except at two points where similar mica-schist outcrops, as far as to sec. 23, 63-17.

On the west side of Oak island, which is the large island in the S. W. ¼ of sec. 23, 63-17, is a large outcrop of confused rock, mica-schist changing to gneiss, cut by dikes of syenite, rising about twenty feet above the lake. No. 938 illustrates the fine-grained condition assumed by the mica-schist in some small areas. South of Oak island the rock of the west shore is hid by boulders nearly to Avis island, but on the east shore are seen several outcrops of mica-schist variously intersected by dikes.

Bear narrows and West bay. At the S. W. ¼ of sec. 29, 63-17, on the shore is a fine exposure of syenite, in which can be seen a narrow greenstone dike running E. and W. two and a half feet wide, and some included mica-schist in the syenite, this being the first instance of mica-schist in the syenite since leaving the N. W. ¼ of sec. 23, 63-17.

The rock is much obscured at the Bear narrows by drift, but it is seen occasionally along the shores on both sides of the lake, and also on some of the numerous islands, being syenite or granite.

Rock 936 is from a small island at the N. W. corner of sec. 32, 63-17. This is somewhat gneissic, and sometimes rather dark for granite.

On the N. E. ¼ of sec. 31, 63-17, a large greenstone outcrop appears, (No. 926), but its contact with the rock of the country can not be seen.

The same rock (syenite) extends through secs. 25 and 24 and into sec. 23, in the next town west (63-18). Near the centre of sec. 23 was obtained sample No. 927.

With but one small exception the rock remains the same through sec.13, 63-18 northeastwardly, and along the south shore in sec. 18, 63-17.

At the S.W. corner of sec. 9, 63-17, is a rock dipping north, containing syenite in lenticular and conformable sheets, some of the sheets being only a quarter of an inch in thickness, and some six inches. The sheets seem to originate in the schist. This rock has an evident bedding structure, dips about north at an angle of about 45 degrees, and seems not to be a mica-schist, but rather more a graywacke. A patch about a rod square is exposed.

Across the bay, northward, on the corresponding point, the exposed rock is a regular mica-schist, nearly vertical, but dipping (apparently) nearly south 85 degrees—not much exposed. Further west, at the fork of the bay, is a rocky knob, 25 to 30 feet high, which consists of mica-schist, plainly dipping south 80 degrees, with homogeneous, small and conformable veins of granite. The same dip continues through sec. 8, 63-17, along the north side of the bay, and in the island in the N. W. ¼ of sec. 8, the rock remaining about the same in character. The geologist can not fail of being struck, however, with the fineness of the interleaved beds of granite or granitic rock, with the mica-schist or gneissic mica-schist, indicating the origination of the former within the latter.

Near the point, on the north shore, near the centre of sec. 7, 63-17, the dip changes to 45° N. E., and this dip continues so far as can be ascertained, through sec. 7.

In the N. E. ¼ of sec. 13, 63-18, the mica-schist along the shore is much interleaved by fine conformable sheets of granite, and rises boldly from the water all along, or overhangs, with a marked and persistent dip N. or N. E., about 60 degrees, reaching a height of 35 to 50 feet. About fifteen rods from the shore are two little islands of granite,* rising about eight feet above the water. These must underlie the schist, when the schist extended so far. This granite, in the islands, has a gneissic foliation dipping E.

* The terms granite and syenite are not used here with careful discrimination.

N. E. The mica-schist extends to some distance west of these islands, but is replaced in about half a mile by the same kind of gneiss as that of the two islands. This is also replaced by mica schist a little further west, rather indicating an alternation of these rocks, though this relation is not demonstrated by connected observations.

Following the mica-schist bluffs westwardly, noting the fine, conformable and increasing number of their sheets of granite; the fact suddenly flashes on the observer that the *rock has become changed to a reddish-gray gneiss*, and a moment's further examination only is needed to show *its further conformable transition to granite*, thus making a conformable passage from one extreme to the other. This interchange is as gradual, and more regular, than that seen to take place between the jaspilyte and the sericitic schists north of Tower. The mica-schist, even after it has become a gneiss, is cut by thin dikes of other, redder granite which is not gneissic but coarsely crystalline. This transition is most beautifully and conspicuously exhibited on the bluff-face at the N. E. corner of sec. 14, 63-18, not far west of the section line.

Rock 929 represents the mica-schist, not gneissic, i. e. not having granite interlaminated, as above.

Rock 930 represents gneissic-mica schist, as above.

Rock 931 represents gneiss, as above.

Rock 932 represents granite, as above.

These numbers were all obtained at the same place, and within a space of forty or fifty feet, the intervals being ten to fifteen feet, all being from conformable beds.

The schist bluff falls away, and after a low spot in the bay, the same transition is repeated along the shore a little further south and west. After an interval of granite at the shore this passes inland, rising higher, and rock 933 appears at the water's edge, dipping in the same direction, showing the same kind of conformable interstratification downward, demonstrating the existence of a large mass of granite *conformably interstratified in mica-schist, and graduating into mica-schist*, above and below. This lower mica-schist is crumpled somewhat.

There are several other transitions, up and down, not all of them revealing granite, but a gneiss, or a gneissic mica-schist, in the shore line along sec. 14, 63-18.

There is much exposure of rock in the N. E. ¼ of sec. 15, 63-18, consisting of mica-schist, often very fine-grained, almost a

dark gneiss, more or less cut by greenstone, and by dikes of granite, the dip changing, with the coastline, toward the W. N. W. The numerous islands are made of the same rock. Rock No. 930 is a sample of granite that is plainly intrusive, i. e. unconformable in its direction, in the mica-schist, obtained at the N. E. ¼ of the N. E. ¼ of sec. 15, 63-18.

Similar schist and gneiss are exposed frequently along Partridge river in secs. 10 and 11, and about the shores of Partridge lake. At the narrows of Partridge lake, in sec. 12, 63-18, on the south side of the lake, a change occurs in the rock and in the dip, the latter being indistinct, but toward the south, or nearly vertical; and the former an aphanitic, hard argillyte, sometimes being cut by, or interbedded with, gneiss of a dark color.

The little island in Partridge lake, near the section line between secs. 11 and 12, is a breccia of mica-schist cemented by quartz and impure quartz, evidently all of chemical origin, some of the cement resembling veins or dikes of the pink or white intrusive granite, suggesting that many, if not all of the unconformable dikes in the mica-schist may be of chemical origin, while the interleaved gneiss, and dikes (so-called) of granite that grade into the mica-schist, are plainly of the same nature as the mica schist, and hence of sedimentary origin.

Rock No. 935 represents some of the impure quartz* from this little island, but it does not fairly represent some of the more granitoid quartz, seen in some of the veins. *It seems there must be some distinction observable, or discoverable, between the dike-granite and the gneiss-granite.*

The direction of the group of islands running through secs. 15 and 21, 63-18, is that of the strike of a great series of hard, gneissic mica-schist, with granite beds and some dikes, the dip gradually becoming N. W. then W. and passing to the point where Wakemawup's village is located. This belt immediately overlies a great formation of granite, as shown not only by observations recorded above, but also by little outlines of the granite in islands lying just east of the Big island. From one of these outliers situated in the N. W. ¼ of sec. 22, 63-18, was obtained rock No. 937. Mr. Stacy examined the extreme northwest extremity of the lake, extending from Wakemawup's village in sec. 21, 63-18, *northwestwardly and northeastwardly* through secs. 20, 17, 9 and 10. He reported finding only rock like that already

* Unfortunately this specimen was lost.

described, viz.: mica-schist interbedded with gneissic rock, and cut by veins or dikes of granite. Sometimes the bluffs rise, in this part of West bay, to the hight of 20 or 30 feet. Along the southwest shore the rock is hid by drift, and boulders constitute the shore line.

The south shore of West bay was examined also by Mr. Stacy. It is chiefly composed of drift, particularly through secs. 27 and 26. In sec. 25, and on the islands in the southeast part of sec. 26, are outcrops of granite or gneiss.

The north shore of Vermilion lake in Towns 63-15 *and* 16. Along the south side of the long point which projects S. W. in sec. 31, 63-16, the rock rises sometimes twenty or thirty feet directly from the water. The rock is mica-schist. It stands nearly vertical but dips southerly (20° E.), i. e. toward the lake, the strike being parallel with the shore. The bedding planes intersect a system of coarse jointage planes that slope in the same direction but run more nearly east and west. When large slabs separate from the bluff in accordance with these planes, and the remaining surface gets weathered, the lines of intersection with the alternating harder and softer layers of the sedimentary bedding, bring out a striation on the weathered face of the bluff that has a deceptive appearance of sedimentary dip, about 45° from the horizon toward the N. W. In passing along, an observer would be likely to take this for the dip, unless he made close examination. That this is not bedding structure is here evident from the fact that there is a true sedimentary structure visible-dipping as stated; and also from the fact that sometimes on the same bluff, a little further toward the east or west, can be seen a similar striation—somewhat wavy—dipping in exactly the opposite direction, produced by a different set of jointage with the true bedding, this set running across the bedding in the direction S. S. W. There is a hard structure, or series of veins of a light color, running all through this rock and forming a network of relief-ridges that cross and recross each other like Widmanstätten figures in a meteorite.

In this mica-schist, further, are dikes of light-colored syenite (or granite) running about east and west, but varying in direction. The color of the schist also varies from nearly white to very dark, by reason of numerous bands that penetrate it coincident with the bedding. These shade through various tints of schistose rock to syenite or granite apparently being perfectly crystalline. This schist has a very evident sedimentary struc-

ture. It is firm and even shows an approximation to gneiss, the foliation of which is then the same as the bedding structure of the schist. When, however, this gneissic structure comes on, the grains are finer than in the gneiss, the color is darker, but the striping, due to sedimentation, is still preserved. The dikes are from two to eight feet wide. Rock No. 13 (H) is the mica schist, and 13 A (H) represents the white dike-rock. Number 13 B (H) is a green trap or diabase which forms narrow dikes in No. 13 (H). This is a very common feature of the bluff.

Shonea island, so named by the Indians from the mining operations carried on for silver near the north side of it in 1866, lies in four different towns, just south of the high peninsula just described. The rock is a hydro-micaceous schist with numerous quartz veins and nodules. It seems to be near the dividing line, geographical as well as lithological, between the mica-schists of the *Vermilion series* and the graywackes and sericitic schists that lie further southeast. It is much obscured by drift, but the dip and strike seem to be conformable with that of the mica-schists lying next north.

The islands lying toward the N. E. from Shonea island in sec. 31, 63-16. consist of an intermediate, greenish, sericitic schist.

Dike-rock [like No. 9 (H)] appears on a small island in the S. E. ¼ of the S. E. ¼ of sec. 31, 63-16. It here runs through a green argillitic slate (939) somewhat crumpled, dipping south in the same manner as the mica-schist seen on the mainland next north, about 75° from the horizon. This schist contains nodules of white quartz somewhat conformable with the dip, as the jaspilyte quartz occurs in the green schist. This green slate seems to graduate into the sericitic schist. It appears again on the south side of the large island in the S. W. ¼ sec. 32, 63-16, and at the N. E. corner of the same island, constituting apparently the continuous course of one or more dikes.

On the S. W. corner of the large island in sec. 32, 63-16, a small dike has a somewhat exceptional appearance. It is represented by No. 12 A (H). and it cuts through—at least it runs in —No. 12 (H). It is porphyritic, and very different from the rock in which it runs, yet it extends in a direction coincident in a general way with the schistose structure, and with the bedding. It varies in width, swelling out and pinching up. At the west end of the island it ceases abruptly, as if it had been faulted since its formation. There are also small lenticular patches of the same kind of rock, running in the same direction, in the

country rock, these being not over half an inch in width, or less, and continuing but a few inches. The weathered, or burnt, surface of the dike is light red, or pink, and the crystals of feldspar stand out, above the surface. The dike here varies from an inch, or less, in width, to eight or ten inches. The country rock is a greenish sericitic schist, very firm, having a coarse schistose structure parallel with the bedding, and apparently dipping 80° from the horizon toward the N. 10° W. This schistose slate is rather conformably placed alongside a different green dike which also has an indistinct schistose or gneissic structure running in the same direction as that of the country rock. In this are quartz veins, and also veins of rock that resemble 12 A (H), but white and less uniform in color and direction. This is about eight or ten feet wide, and then is replaced by green schist on the north side again. This green schist is No. 12 B (H).

On the west end of the island in the N. E. ¼ of sec. 32, 63-16, are visible seventeen dikes, from an inch to two feet in thickness, in the space of sixty feet. They run about 20° N. of E. The schist through which they run has considerable mica in some parts of it; in other places none at all. On the S. E. end of the same island the schist is sericitic, and has a very little mica in it. On the east end the schist seems to be sericitic, and is very micaceous. There are dikes in it, as usual, of pinkish and gray syenite. On the point near the south line of sec. 28 the rock is more like graywacke, and seems to have no mica in it.

Through sections 28, 27, 23, 26 and 25, in T. 63-16, the north shore of the lake consists, in general, of mica-schist and granite, irregularly mingled, but these rocks show remarkable variations, the former becoming hornblendic and massive, and passing apparently into syenite or dioryte, and the latter becoming very coarsely granular, and very often red.

At the centre of sec. 27, 63-16, the schists are micaceous, and apparently chloritic, and stand nearly vertical, cut by numerous white dikes.

In the N. E. ¼ of the same section, the rock is micaceous graywacke, standing vertical, crossed in all directions by granitic dikes, though the most of these are in the direction of the bedding. The strike is ten degrees south of east. The same strike and dip appear again on the shore south of the bay situated near the centre of section 26, 63-16.

Mr. Stacy, who examined the north shore through secs. 27,

23, 26 and 25, 63-16, procured the samples numbered 940-947, to show the variations in the rock.

Sample No. 940 from S. W. ¼ sec. 23, 63-16, is not very common, and rather an extreme for coarseness; 941, from the same place, rather common; 942, N. W. ¼ sec. 25, composes a large bluff; varies to a rock like 941, both being red granites; 943, from N. E. ¼ sec. 27, from the same bluff as 940 and 941, a common rock; 944, from near the centre of sec 27, one of the phases of the rock common to the country; 945, from the S. W. ¼ sec. 23, mica-schist, hornblendic, rather a micaceous gneiss; 946, N. E. ¼ sec. 27, red micaceous gneiss.

In sec. 25, along the south side of the same bay, the rock is reported by Mr. Stacy as very nearly graywacke, but the samples he obtained are more nearly a fine mica-schist, evidently about on the verge of transition from one rock to the other; bedding about vertical. Along the north shore of the bay, extending from the town line eastward in T. 63-15, he reported that he found only graywacke, and "a graywacke slate, varying to porodyte," as on a point where a high perpendicular bluff appears on the shore in the N. E. ¼ sec. 3, 62-15, where he obtained rock 947, which is a poroditic graywacke. The slaty graywacke sometimes was seen to vary to a slaty sericitic schist. Such was seen about half a mile northwest from the place where the rock 947 was obtained.

Eastward of Pine island the north shore of the lake is caused by the extension of the hills of graywacke which begin in sec. 4, on Pine island, and these hills will rise sometimes 175 feet above the lake. On a little island near the centre of sec. 4, 62-15. the rock is a slaty graywacke, dipping 60° N. and 30° W. with no schistose structure at variance with the bedding, though cut by numerous joints in all directions. In some of its coarse beds this graywacke approximates on weathered surfaces, the appearance of some of the porodyte, especially some of the schistose porodyte. In other places, further east, it is somewhat conglomeritic, the stones being now evinced by a tortuosity of all the structural arrangements about there, and being particularly evident on the weathered surfaces.

Pine island. The western end of Pine island, through sec. 34, 63-16, has numerous outcrops of sericitic schist and graywacke, dipping toward the southeast, the land rising, at short distances from the shore, from fifteen to thirty feet. A greenstone dike is visible on the shore in the N. W. ¼ of sec. 34, 63-6, running about E. and W.

In the promontory-like point that juts out northwestward in sec. 27, 63-16, the schists are vertical, and are crossed by dikes of granite.

The islands, and the coast-line, in sec. 26, 63-16, are composed of the same rock (a graywacke which sometimes is micaceous) and is cut by dikes of light colored granite, the strike of the schist being to the south of east.

On the north part of sec. 35, 63-16, are some bare hills. These consist of micaceous graywacke, the strike being 10 degrees south of east. It is disturbed by dikes of greenstone that run about E. and W. These weather gray, like the wacke, but by fracture, and by their unconformity with the rest of the rock, they are seen to be of eruptive origin. Their width varies from three inches to thirty inches. No granite dikes are visible here. The land is about 50 feet above the lake; and though the strike is about E. and W., the hills ascend like sheep's backs running from north toward the south, ascending from the shore; and coalescing, further south, in a general elevation more bushy and scantily timbered, at about the same hight. These hills have the form of glaciated domes, but fires and frosts have destroyed the markings.

Besides the foregoing greenstone dikes, there is another kind of igneous rock here, represented by rock 881, which is a rather fine dike-rock, running about parallel with the strike, but cut by the other greenstone dikes. This weathers much lighter colored, and the course of the darker greenstone of the other dikes can be seen crossing it, though nearly parallel, by the contrasting bands of color.

At the extremity of the point that projects eastwardly from sec. 35, into the N. W. ¼ of sec. 36, 63-16, was obtained rock sample No. 882. This is coarsely schistose, and somewhat confusedly so, contains some patches of red syenite, and has a red mineral disseminated through it, but its general color is green, due to a rather soft, foliated, green mineral like chlorite, that is perhaps changed from hornblende. The red mineral is a feldspar, and the aspect of the outcrop is that of a rotted igneous rock. This may be compared to No. 12 A (H).

At the point at the narrows, sec. 36, 63-16, projecting westwardly, the rock is about vertical, runs E. and W. (or nearly) and consists of a rather micaceous graywacke, and is cut, conformable to the schistose structure, by a greenstone dike, about 2½ feet wide, which forms the breakwater toward the S. W. and makes the extremity of the point.

Boulders and slight outcrops of sericitic schist constitute the shore eastward through the rest of Pine island.

At the N. E. ¼ sec. 5, 62-15, is a fissile schist of a gray color, crumbling down under the weather, which probably underlies much of the shore further west, though unseen because of the drift covering, and the ease with which it is destroyed by the weather. It is seen here because the shore line faces the prevailing and strong westward winds, and the exposure is kept fresh by waves and drifting ice. It rises about ten feet in the bluff. It contains lumps of black chert or hornstone. This rock is No. 883.

The southeastern extremity of Pine island is very rough, the hills near the shore rising fifty or seventy-five feet above the lake. The rock here is mainly graywacke varying to sericitic schist, also becoming poroditic, the latter in the western part of sec. 4, 62-15, and the eastern part of sec. 5.

At the S. E. ¼ of sec. 6, 62-15 (E. side of the bay), the graywacke (?) has a massive structure, and sometimes a basaltic jointage, approaching porodyte. It is represented by sample 920. It contains crystalline grains. It dips N. 80°. On the weathered and glaciated surface the sedimentary banding is visible, and beds of argillyte, and angular, isolated pieces of argillyte, can be seen distinctly, embraced unconformably in the granular graywacke, but not on so grand a scale as those seen on sec. 20, 62-15.

A little north of the point, within the bay, on the east side, is a low exposure, on a small low point, of a greenstone dike, the dike being about 20 feet wide and apparently running in the same direction as the schists.

At the entrance to the bay, on sec. 6, 62-15, on the south side of the island, the same kind of graywacke appears on the west side as on the east. The rock is hard and tough and has nodules and straggling veins of chemical quartz.

At the S. W. ¼ of sec. 6, 62-15, where the town line crosses the shore of Pine island, is a large lot of clay slate, which has the appearance of being economically valuable. It is black, and purplish black. Large blocks lie on the beach. It rises also into the adjacent bluffs, ten to twenty feet high. Sample 921.

On the shore S. W. ¼ sec. 1, 62-16, is a greenstone dike cutting argillyte, but in the highest part of the ridge, which rises about 40 feet, while the general facies of the rock is that of greenstone, and it seems to have sufficient toughness, its color

and fine granular texture resemble those of some fine graywacke. It is only after considerable examination that an opinion can be formed as to the nature of this rock. Sample No. 922 represents this indefinite rock. At the section line between secs. 1 and 2, a little further west, this rock rises in a cliff, breaking off toward the west. It is here plainly a hardened sedimentary rock, exhibiting the regular sedimentary banding. In most of this exposure this rock appears as a hardened and basaltified graywacke and argillyte. It is distinct, however, from the greenstone dike mentioned, which runs westward through it.

The rounded point which extends southward from sec. 2, 62-16, into sec. 11, consists of drift, and the shore line shows only boulders and gravel. Graywacke, alternating with stretches of sand, or of boulders, with marshy spots in the bays, extends thence northwestward to the north line of the town.

The island which lies in secs. 11 and 12, 62-16, has frequent exposures of graywacke. On the northwest coast it verges toward argillyte.

Ely island. The following notes on Ely island were made chiefly by Mr. H. V. Winchell.

On the south half of sec. 17, 62-15, the rock has the same structure as No. 2 (H). It is, however, finer-grained, and seems to be more "talcose," but it contains occasional grains of free quartz. The schistose structure runs about ten degrees north of east. The bedding is not apparent, but the schist stands vertical.

In the S. E. ¼ of sec. 17, 62-15, this rock holds more numerous grains of quartz. In some places, but not generally, there is an evident basaltic structure. There are also seen here pebbles of No. 2 A (H). On one of the highest knobs the free quartz granules are about as numerous as in No. 1 (H), and there are other pebbles, six inches in diameter, of quartzyte and other hard rocks, compressed, or worn, so as to agree with the schistose direction of the rock. No. 2 B (H) are pebbles from this felsitic conglomerate. Veins of white quartz run in various directions through it, principally east and west. In one place, about on the S. E. ¼ sec. 17, such veins are only a few inches apart, and vary in thickness from one to six or eight inches. This rock weathers into thin scales, finely broken up and nearly always parallel with each other.

Boulders of granite, mica-schist, syenite, etc., are found on the top of the highest parts of this island, sixty feet or more above the lake.

In the N. E. ¼ sec. 20, 62-15, the felsyte gives way to the graywacke, which has its bedding and schistose structure both running east and west, standing vertical or perhaps dipping to the north. The felsyte lies unconformably on the graywacke.

At the S. E. ¼ of the S. E. ¼ of sec. 17, 62-15, west of the bay, the two rocks come together and mingle with each other. There seems to be an alternation of graywacke and felsyte in several successive beds, the graywacke prevailing in one direction and the felsyte in the other. The sedimentary bedding of the graywacke runs 35° N. of E. and the schistose structure E. and W. The section line between secs. 16 and 21 is about the line of division between the felsyte in sec. 16, and graywacke in sec. 21. They lie side by side on the east side of the bay, corresponding to the same position on the west side.

On the east side of the point, in the S. W. ¼ of sec. 16, 62-15, the felsyte lies unconformably on the graywacke. At the same place the former changes from a homogeneous mass of rock to a conglomerate containing rocks but little changed from their natural state.

The felsyte continues along the shore in the S. E. ¼ of the S. W. ¼ sec. 16, 62-15, but it is not so homogeneous. There are patches where it is quite conglomeritic, the schistose structure continuing E. and W. There are portions of it, sometimes ten feet in width, and of indefinite length, running in the same direction as the schistose structure, which are much softer, and are generally much decomposed, and fallen down, as though there were a mineral in it much softer than that of which the rock is generally composed.

On the south side of the island, in N. E. ¼ of sec. 15, the felsyte changes into a fine-grained greenstone, varying from quartz-dioryte to slate. Around on the end of the point it changes back to the light-colored homogeneous felsyte, containing a few free quartz grains. On the north side of the island, in sec. 15, 62-15, the underlying rock is not so much exposed, as on the south side. It is all the same kind of rock, varying between felsyte and conglomerate.

In the S. E. ¼ of the N. E. ¼ of sec. 16, 62-15, the conglomerate has a schistose structure running about 20° N. of E. There are in it pebbles of jasper, red and black, quartz grains or lumps, and pieces of rock like No. 3 (H), which is a sericitic (?) schist varying in the coarseness of its structure from a rock that resembles No. 1 (H), to slate. It may contain lime.

In the N. E. ¼ of sec. 17, 62-15, the rock rises high, forming rough hills. These hills are rounded somewhat but have been roughened since. The north sides of all these knobs are more decomposed than the south sides. The rock is about the same as that of which the island is chiefly composed, but here it weathers whitish, while further east it has chiefly a greenish color when weathered. In it are the same pebbles as usual, and some pyrites. None of those greenish pebbles found on the mainland south of the lake, and numbered 2 A (H) are here to be seen.

In the south half of the N. E. ¼ of sec. 17, 62-15, there is a quartz vein in this rock ten feet thick. It does not appear to be very long, nor to contain anything but occasional lumps of the rock itself. It has been blasted "for gold" for a length of thirty feet or more. It occupies a rough jointage opening in the felsyte, dipping northeasterly about 75° from the horizon.

On the point in the N. E. ¼ of the S. W. ¼, sec. 17, the graywacke again is found. It has a dip to the north and an east and west schistose structure. It does not rise over fifteen feet above the lake. As the west side of the point is reached the felsyte again appears, forming the whole of the west half of the point rising about 20 feet above the lake.

The east end and the south shore. Along the north shore of Mud Creek bay are occasional exposures of graywacke. Hills of the same rise from 50 to 70 feet above the water near the bay. On the south shore, near the mouth of Mud creek, is a hill about 125 feet high, and this extends, with slight variation, for nearly a mile toward the west, into sec. 12, 62-15. Graywacke dipping N. 70°-80° appears on the shore on the point in the N. W. ¼ of sec. 12. The islands in the bay are composed of the same rock, with a strike nearly E. and W.

In the southern part of sec. 12, 62-15, a large outflow of eruptive greenstone makes its appearance (875). It has an indeterminate width, and only a conjectured direction. It shows for nearly 200 feet, and makes a bold, high eminence, from which the large basaltic (or roughly and coarsely jointed) blocks fall down on the beach, the hight of the shore here being about 35 feet. The conglomerate, through which it seems to cut, is blackened and hardened on the south side, for a distance of eight or ten feet.

The exact point, which sharply projects on the south side of the next bay north, is made of conglomerate; but a short distance within Mud Creek bay, on the south side, the slaty graywacke makes its appearance.

The quartz which is seen near the north line of sec. 13, 62-15, is of small extent. It is white, and appears conspicuous from the lake, in passing along. It runs in an irregular ascending deposit about 40 feet and pinches out at both ends, being about four feet wide near the middle. To the north some quartz deposits of the same kind are visible, in smaller areas, following the irregular, angular openings that were made in the formation, when it was fractured. The inclosing rock, just at the "vein," is a siliceous graywacke or porodyte, dipping north uniform with the dip in this part of the country generally, but it soon changes to the arenaceous porodyte, or conglomeritic porodyte (also styled felsyte) so common about the east end of Vermilion lake. In about a couple of rods further north, on the highest part of the hill, this conglomerate is broken, and mingled with a broken graywacke, the bedding planes of the latter being warped, and, over an area of a rod, having a distinct dip toward the east. In this vein is seen a little bornite and chalcopyrite, but it has not been worked any more, since I visited it eight years ago.

The felsitic conglomerate, or conglomeritic felsyte, already spoken of, forms the underlying rock toward the south, and about Armstrong bay, but is hid badly by drift and by forest.

This poroditic rock, generally containing rounded boulders, extends through the islands and coastline, from the head of Armstrong bay westward to Stuntz island. There were noticed only two points at which there is any variation.

One consisted of a thin layer of rather more fragile schist, lying between a dark gray quartzyte, on the north, and the conglomeritic felsyte on the south. This was in the northern part of sec. 13, 52-15. The other was on the N. E. ¼ of sec. 22, 62-15, on a small island, where, as well as on the main land east of the island, a quartzitic, dark graywacke, was seen standing in nearly perpendicular coarse jointage somewhat coarsely slaty.

Everywhere, about the S. E. end of the lake, when any dip is visible, it is toward the north, generally 80°-85°, but at one of the small islands in sec. 21, it was seen as low as 60 degrees.

Stuntz island rises from 25 to 30 feet. It is in the east part of sec. 21, 62-15, and forms a bar across the entrance to Stuntz bay, leaving but narrow passages at the ends. It exhibits several very interesting geological features. The shape of the island is something like the figure below (Fig. 34). The southern, more elongated, part is made up of the conglomeritic felsyte, mentioned, and the shorter peninsula, on the north side, is of the

Fig. 34.

Fig. 34.—*Showing Stuntz island.*

same felsyte sometimes with a basaltic structure, and sometimes with free quartz but not conspicuously conglomeritic. In the conglomeritic portion are two sets of dikes, the main one consisting of one large dike and several branches and narrow wedge-shaped masses of doleryte, running E. 10° S. Sample 872 represents it. See also a photograph.

The rock of the other set of dikes is now in the condition of a greenish chloritic schist (see rock 873). This series is not so conspicuous, nor so numerous, as the other, but shows two distinct narrow dikes about eight and eighteen inches in width, running ten degrees north of east, thus forming an angle of twenty degrees with the other set. It was for some time a matter of doubt whether these were true dikes. They manifest a schistose structure parallel with that of the felsyte, and also parallel with the bedding structure of the region so far as any such is visible. They are soft, easily shattered, and also appear as short, isolated belts, sometimes not running more than ten feet before they pinch out, though one of them can be followed a distance of more than sixty feet, when it becomes invisible by running under turf and bushes. In one case one of these splits, and forks round a portion of the conglomerate. One fork dies out quickly, but the northerly one continues for twenty feet, before it is lost under the soil and vegetation. They also contain a few fragments of jasperoid quartz, and rarely some rounded pebbles of more coarsely crystalline rock like themselves, or like the rock of which they, perhaps, originally consisted. That which furnished finally incontestable proof that

this system also constitutes a series of true dikes was the discovery, after clearing away the turf, that they cut the other dikes, maintaining their identity of structure, and their walls intact right across them. They must therefore not only be true dikes, originally crystalline doleritic rock, but they must be of somewhat later date. The dike-like character of the other system is most evident, not only in the manner of crossing the formation, and forming angular jogs, but in the basaltic form of the rock and its doleritic nature. The mineral nature of the later system seems now to differ from that of the older only in being more changed by decay. This may be due to the accident of its direction being coincident with the subsequent development of the schistose structure, allowing not only a complete fibrous internal rearrangement, but, afterward, a more ready access to all disintegrating agents. No. 873 A is a rounded ball of green rock taken from the second system. Only two or three of these were seen. In both series can be seen pieces of jasperoid rock.

The conglomerate itself is coarse, some of the stones being more than a foot across. Stones make up the whole of it, in some places, but in others they are small and scattered, or fail entirely. There is, even in the coarsest portion, a little schistose, sericitic (?) material, with all its scales and fibres elongated in the direction of the greater diameter of the pebbles, that twists about between the boulders, its laminæ about parallel to the sides of the inclosed stones. The stones and the matrix have a general similarity or approximate identity of mineral composition and color. The weathering color, particularly of the stones, is nearly white, but there is a dull greenish tinge, in the matrix. On fracture, a light green color is at once apparent in the stones, and a darker green, or a grayish green, in the matrix. The stones contain much semi-rounded quartz, in grains of all sizes up to one-sixteenth inch across, while the matrix not only contains these, but seems to be porphyritic sometimes with white feldspar. The pebbles themselves are chiefly a greenish felsyte and show a fibrous internal elongation in the same direction as that of the matrix, but they are more durable than the matrix, and often stand out distinctly on the weathered surfaces.

This conglomerate also contains many pieces of jasperoid quartz showing a fine banding like that in the ore-rock of the mines. Sometimes this is placed across the schistose structure, but it generally is parallel with it, and the pieces then seem

to have the same superinduced lengthening in that direction which is evinced by the rounded boulders, of the other kinds of rock. This seems to show unmistakably a difference of age between the jaspilyte of the hills and the sericitic schists associated with it, and this conglomerate.

The lengthening, or compressing, of the stones in this conglomerate need not all be attributable to the effect of the superinduced schistosity, which must have been caused since the later system of dikes, since if any stone, whatever its source or nature, not absolutely round, be cast into a liquid, whether water, mud, or ash, it would assume a position, when it came to rest at the bottom, approximately with its flattened sides, or at least with its elongation, parallel with the bottom on which it came to rest, and would remain so, in whatever direction the bedding might be tilted. There is no evident sedimentary structure in this conglomerate, but there is a coarse structure, somewhat wavy, simulating a succession of sedimentary or other manner of accumulation, which dips toward the south or stands nearly vertical.

No. 872 A was taken from the side of a narrow dike of the main system on Stuntz island. This dike is not more than 1½ inches thick where the piece was taken off, and pinches out entirely toward the west further, in about ten feet.

In the northern part of Stuntz island are veins of quartz up to a foot in width, running through the felsyte. The felsyte runs parallel with the conglomerate, and merges into it. Some light-green serpentinous pebbles are here seen in the felsyte, represented by No. 2 A (H), the felsyte being No. 2 (H) and 874 B. These bits of light-green rock are uniformly elongated with the schistose structure, and their schistose structure runs in the same direction, but is, of course, much finer. These bits seem to be referable to some basic greenstone outcrop which supplied fragments to the conglomerate as it was forming. By the elongating, and schistizing and weathering agents to which they have since been subjected, such bits have been converted, not into the homogeneous porodyte, or felsyte, but into these serpentinous, soft, green, pieces, because of a difference of original mineral character. This hypothesis is strengthened somewhat by the existence of what appears to be a piece of olivinitic greenstone (874 B) in this felsitic rock in such a position as to have been protected partly, from change by some large quartz veins that lie adjacent. This,

however, was not in agreement with the schistose structure, but conformable to the quartz vein, which ran across the structure.

On close inspection of the rock that forms the northern half of the island, although it is apparently entirely homogeneous, yet in nearly all parts there is an indistinct interval structure, evinced by faint blotches of lighter color and by warping of the laminæ of foliation about such invisible shapes within the rock-mass, that shows there were conglomeritic fragments, of about the same material as the matrix, continually being added to the forming rock. These are now so blended with the surrounding mass, and so nearly identical in composition and grain, that they can be identified only when the process of weathering, that unerring detective ally as well as most successful deceiver, of the geologist, brings their forms partially into view. In this part of the island, however, are seen none of the jasper fragments that are so common in the southern. The rock, instead, contains in some places much free quartz, some of it being in coarse grains even as large as a quarter of an inch in diameter, not evidently as perfect crystals.

Since the quartzyte and jasper pieces in this rock are placed with their elongated axes parallel with the schistose structure, and also parallel with a rude foliation which might be called bedding, but do not partake of the schistose structure, and are not changed from their original angular shapes, it is evident that the general elongation of the boulders in the mass in the same direction is not due to the schistizing process, but that they assumed the position that they have, as well as the forms that they exhibit, prior to, at least independently of, that process, and under the action of some force more powerful and more widespread than it. It could be no other than that which originated the conglomerate rock itself. On the supposition that this foliation is the original sedimentary bedding, it is easy to understand that under the action of sedimentation, all stones would lie on the bottom flatwise—or nearly all—and that they would agree in their principal dimensions, with the bedding planes. This force then may have put all these stones in the sediments in a uniformly flat direction, coincident with the bedding and none of them may have been changed in shape since they were deposited.

If the structure referred to here as foliation be not the result of true sedimentary bedding it must be due to a semi-fluid condition of eruptive rock, in other words a *flowage structure*, under which

there would be the same tendency for all hardened rocks of similar character. inclosed in the pasty or molten mass, to arrange themselves parallel with the direction of the slow movement, especially if it be one accompanied by a progressive accumulation.

In the central part of Stuntz island the structure of the rock varies in belts, along indistinct lines of contact. The rock is essentially alike in composition, but different in the fineness of the sub-crystalline grains and in the schistic structure. The finer grain and structure are apparently cut across by lines of contact with other rock, but a parallel schistose structure, though coarser, is perpetuated in the coarser rock. These are both without apparent boulders, are fine-grained, feldspathic, without apparent free quartz, and are represented by 2 (H), the coarser one embracing small lenticular bits of soft, greenish serpentinous slate. They both have an imperfect basaltic jointage. Beyond these, that is, toward the south, a coarser rock again comes in, having a similar abrupt line of contact and transition, the fine-grained belt being about 12 feet across. This has the same general color and finely sub-crystalline feldspathic composition, but is not so completely homogeneous. On careful examination and particularly on weathered, or burnt, surfaces, can be seen distinctly, small areas of lighter color and denser grain, though more porphyritic, with some elongation in the direction of the schistosity. The forms of these areas are seen to be rounded whenever their shapes are made evident by the exfoliation of the surface by the action of the fires that have rendered the island nearly bare rock, simulating those of the conglomerate, and suggesting that even within this homogeneous rock are still the nuclei of pebbles and stones, and that the whole of it may have been at first a coarse conglomerate of pebbles of one sort of rock. The following figure (No. 35) shows this manner of alternation of differently schistose belts.

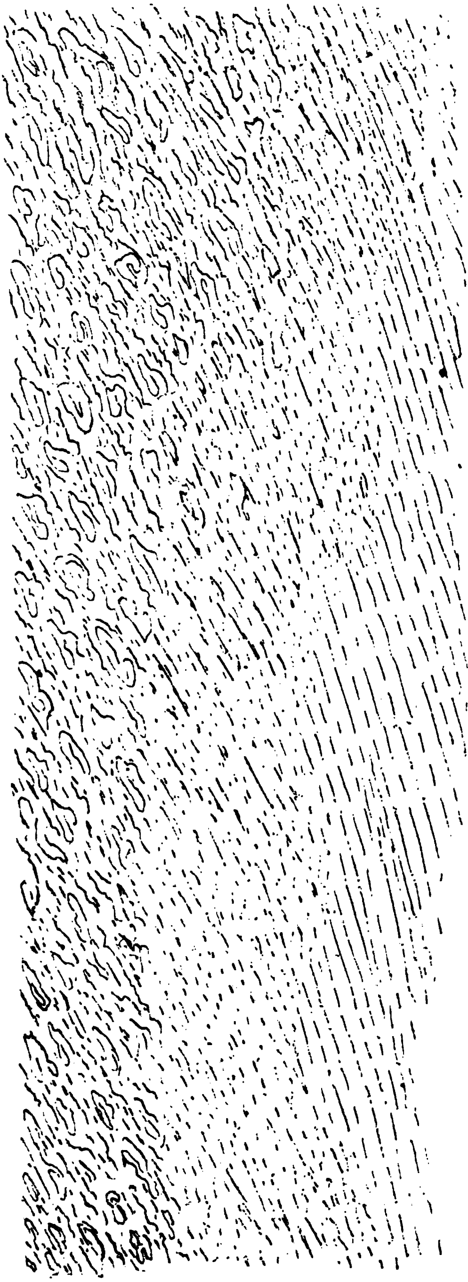


Fig. 35.

Fig. 35.—*Showing differently schistose belts in the felsitic conglomeration of Stuntz island.*

There are, then, steps of change, so far as I can see from No. 1 (H), through 2 (H) to 874, that show that the igneous characters of such rock as is basaltic or dike-like, can be referred to a fused condition of the rock constituted of conglomeritic matter, and the subsequent mingling of the molten rock with that which was semi-molten, and that which was simply plastic, or that remained rigid. Whatever the original genesis of one, was also that of the other. Whether the fused condition was prior, or subsequent to the formation of the mass as rock, is not here considered. It is evident, from these facts, only that the coarsely fragmental state was very widespread, permeating even very fine-grained rocks, and that the evidence of heat, and even fusion, extends through both. In that sense, if in nothing further, they are both igneous rocks, but they may not have come from any deep source, like the green dike-rock of Nos. 872 and 873.

At about ten rods south from the point from which was taken the sketch of Fig. 35, the coarsely conglomeritic rock rises in great domes that show their coarse boulders by the blotches that appear on the surface, as well as by differences in texture and some variation in composition—though here also a general sameness of mineral character pervades both the boulders and the matrix.

About the shore of Stuntz bay, except where boulders constitute the shore-line, and on the islands, this conglomeritic rock, or some phase of it, is seen, with only one exception. That exception is on the point at the extreme southeast corner of sec. 21, 62-15, and on the island adjacent where bedded graywacke slate appears. It stands nearly vertical, but dips north, 80°-85°, and runs under some rock like that of the north side of Stuntz island, the latter here acting like an eruptive rock in being non-conformable with the bedding of the slates. This slate varies in strike so that in some places the schistose structure makes a sharp angle with the bedding. At this place, as well as on Stuntz island, and at Pike river falls, there is evidence of twisting and warping made since the production of the schistose structure.

The point southwest from Stuntz island is made of the same kind of rock as Stuntz island. It rises fifty feet above the water, nearly vertical, but in some places the evident structure dips toward the south. In some places it shows lenticular masses of rock not conglomeritic, quartzose with basaltic jointage, which

crowds over and cuts across the schistose structure of the conglomerate and of other rock, and plays the role of an igneous rock. This is represented by No. 1 (H), though the rock having this number was not obtained here. The rock having this igneous manner seems sometimes to be involved in the conglomerate somewhat like a dike, but really wedging out toward the east. Its contact with the conglomerate shows nothing noteworthy. There is nothing indicating any effect that it had on the conglomerate. There is simply an abrupt transition from a schistose, coarse rock with boulders to one without boulders, of about the same color, massive or coarsely jointed in a basaltiform manner, and homogeneous in mineral characters.

At the head of the small bay at the S. W. ¼ of sec. 21, 62-15, is a brecciated condition of the various schists of the region. Toward the northwest from this, on the point extending into the lake in the S. E. ¼ of sec. 20, 62-15, were made many interesting observations. Some of these have been given in the former chapter in discussing the origin of the iron ores, and some others are given below.

The point in S. E. ¼ of sec. 20, 62-15, embraces a varied geology. There is a confused breccia, or apparently a mingling at least, of graywacke, argillyte, sericitic schist, conglomerate and felsyte. Graywacke and argillyte constitute the greater part of the rock at the surface, particularly in the northern portions of the peninsula. The bedding direction of this, while distorted and reversed over small spaces, yet runs in general nearly coincident with the schistose structure, and is nearly vertical. Toward the south further, the peninsula develops into a prominent ridge elongated northwest and southeast, consisting of a coarse breccia of jaspilyte. This extends several rods, gradually acquiring more rounded pebbles of jasper, then rounded pebbles like those seen in the Stuntz island conglomerate (the jasper pebbles becoming white quartzyte), and at last, just before it disappears on the east side of the point, it presents very much the aspect of the conglomerate which forms the bold shore line on the north side of the point in sec. 21, and which extends to Stuntz island. About half the pebbles are of white quartzyte, the rest being white, quartzose porodyte. It has some bands of fine greenish schist running conformably through it, the same also forming the matrix.

Further north, on the same point, near the centre of the quarter-section, is another exposure of jaspilyte, some of it being

hematitic. It is twisted, broken, and in general has a banded strike toward the north, then to the northwest, and then about west, and suddenly ceases. It graduates, toward the north further, into the same green schist, which at once becomes a conglomerate of white quartzyte and porodyte. This jasper area, which rises so as to form some of the higher parts of the peninsula, is itself a conglomerate, as it holds some rounded as well as angular pieces. Indeed there are strata or belts of fine jasper-conglomerate, with the schist-matrix, running zigzag through the coarse mass, not conformable with the banding of the main jasper masses, but at various angles. In the midst of the whole can sometimes be seen small patches of the green schist that forms the matrix.

Apparently the green schist here mentioned is the same as that seen at the mines at Tower unconformable on the jaspilyte. It seems to graduate, on sec. 20, 62-15, into the rock No. 1 (H), which has many features of an igneous rock. This last is found a little west of the conglomerate areas last mentioned, on the same peninsula, and is associated there unconformably with graywacke and argillyte. It is not here generally spread, but a patch about 30 feet across strikes diagonally across the graywacke. It has a perfect basaltic, columnar structure, and contains semi-rounded quartz grains distributed somewhat like quartz in a porphyry, though not of uniform size. It appears as if it could have been produced by the fusion of the materials of the surrounding rock. This belt extends toward the east, but seems to divide into two parts. At a place northeast from where this rock divides, following an exposed low ridge of rock, mostly of slaty graywacke and graywacke, the latter rock is seen to change across the bedding to fissile argillyte, then to sericitic (?) schist, then to hold masses of jaspery quartzyte and black chert, the schistose structure winding about them, and filling all their sinuosities, the same as noted north of Tower. This observation shows the intimate relation between this green schist and the argillyte, one changing to the other.

In this green schist are not only large masses of jaspilyte but pebbles of granular white quartzyte, like the "chalcedonic quartz" of the ore-rock, some of the latter being an inch or two in diameter.

The same basaltic rock is found on a small island about 25 feet across, just north of the point last mentioned, but here it is finer-grained.

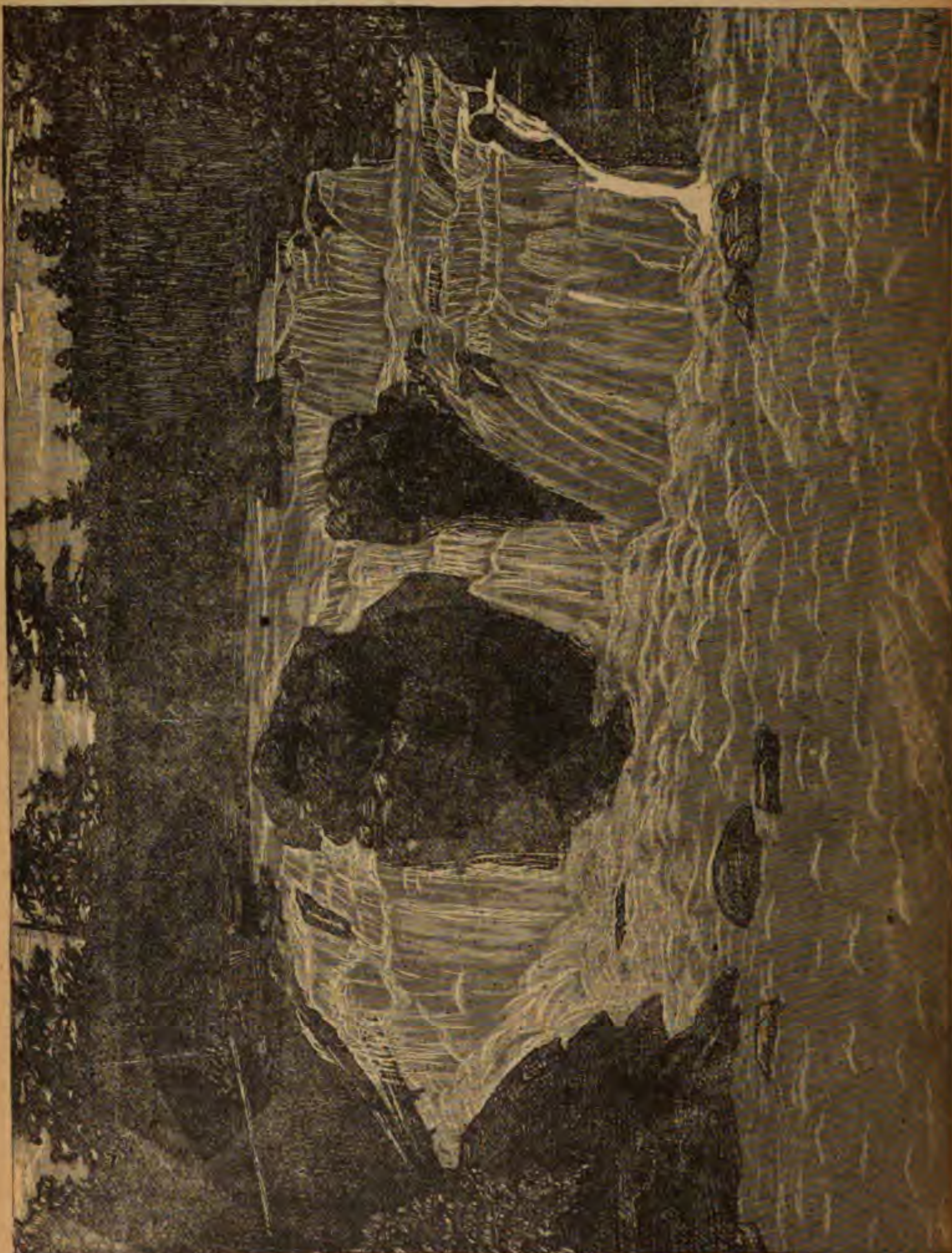
The larger island, in the east half of sec. 20, 62-15, consists of conglomerate, rising about 20 feet above the lake. The inclosures are of all sizes up to a foot in diameter. There is a vertical schistose structure running about east and west, in which all the rounded masses seem to have been compressed and elongated. Some of the included masses are banded black chert, eight to ten inches long.

The shore-line of the bay in the south part of sec. 20, 62-15, is chiefly occupied by boulders, but graywacke appears on the western side, nearly where the section line intersects the shore. Further west, on the point in the S. W. ¼ of sec. 20, 62-15, is seen a good exposure of bedded graywacke rising gently from the water-level, smoothly glaciated, but exhibiting the anomalous strike N. W. and S. E. The point, a little further from the water, rises to about fifteen feet. Thence to Hoodoo point the shore-line is formed by drift materials.

Some small islands in Vermilion lake. Kid island, which is in the S. E. ¼ of sec. 18, 62-15, rises about twenty-five feet above the lake. It consists of a slaty graywacke on the south side, and the felsitic rock seen on Ely island, on the north side.

The island in the S. E. ¼ of sec. 7, 62-15, has on the north side an exposure of "sericitic" schist, with abundant interlaminations of silica, or siliceous material, dipping 80° toward the north. The silica bands here, in their manner of distribution, resemble those that gradually encroach on the green schist at points noted north of Tower, where the fragmental jaspilyte fades out and gives place to the schist entirely. This rock forms the island.

Key island, which is situated in the southern part of sec. 11, 52-15, is underlain by graywacke rock, visible at the southwest and the eastern ends of the island, but the small islands south of the eastern extremity of Key island, in sec. 11, 62-15, are composed of the felsitic conglomerate the same that forms Ely island.



KAWASACHONG FALLS, KAWISHIWI RIVER, BIRCH LAKE AND RIVER AND DUNKA RIVER.

Kawasachong falls. This fine-water power is formed by the Kawishiwi* river near its entrance into Fall lake. It is represented by the accompanying sketch, which was drawn by Mrs. M. S. Mowry from a photograph made by the writer in August, 1886.

The rock here exposed was referred to in the report of 1880 (No. 356). It is an important and typical rock of the region, and seems to play a leading part, in towns further south and east, in producing some of the principal topographic features. It is represented by samples 997, 998 and 999. It is a green doleritic rock, more or less affected by decay, lies in heavy, irregular bedding that slopes northward at a greater angle than the descent of the river through the rapids from Garden lake to Fall lake. This bedding is variously blocked out by joints, and sometimes it shows a columnar structure. The beds are unconformable with some jaspilyte which appears on the right bank near the head of the rapids, and on the trail near the same place, apparently lying on the upturned vertical beds of the jaspilyte. This jaspilyte is more correctly styled a magnetic quartz-schist. It stands in sheets nearly vertical, yet dipping north. It is dark-colored, but sometimes is reddened with hematite. Sample No. 1000.

This heavily bedded, rough, refractory doleritic rock can be of no other than eruptive origin. It is supposed to be inferior to the principal gabbro masses of the Mesabi range, as will appear by further descriptions, and some phase of it forms the contact rock on other, nearly vertical, strata in nearly all places where the junction line can be seen. It extends southward indefinitely, giving some characteristic outcrops on Garden lake and in the eastern portions of Kawishiwi valley.

The geological situation at Kawasachong falls is expressed, in general, by the following diagram, which shows a section north and south through the falls:

*The Grand Marais Indians apply the name *Kawasachong* to Fall lake, meaning mist or foam lake, referring to the spray and mist produced by these falls, visible to the canoe-man who coasts along the shore past the mouth of this river. This name and this spelling were obtained of the well-known Indian guide and trapper, Paul Morrison, by the writer in 1878 and, on account of some doubt of their correctness, they were again given by him to the writer in 1886.

Fig. 37.

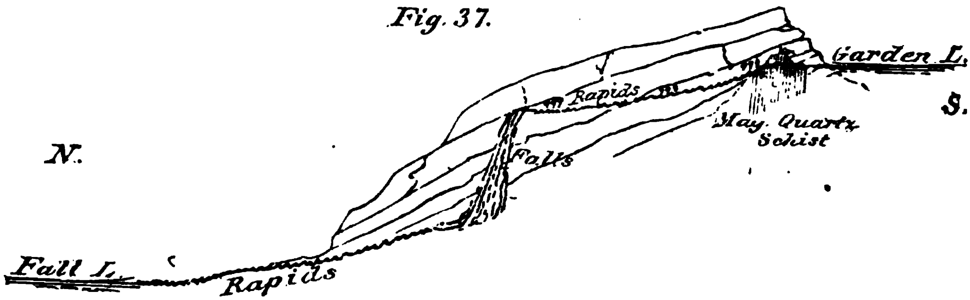


Fig. 37.—*Profile through Kawasachong falls, from Fall lake to Garden lake.*

The south shore of Fall lake. Westward from the mouth of the Kawishiwi river, the rock that forms the falls continues, forming rather high land, particularly in the point that projects into sec. 17, 63-11. It appears at the shore on the point in the N. E. cor. of sec. 19, 63-11, where the bluff rises about twenty feet.

Near the centre of sec. 19, 63-11, at the lake shore, is a confused "sericitic schist," near the water, coarsely fissile lenticularly, not soft, but with a jagged upper surface, represented by No. 1004. The prevailing structure in this, dips southerly. Above this rock, in the same bluff, is a rock represented by 1005, which is a doleritic rock, probably the representative of the Kawasachong falls rock. It has a coarse jointage, and an irreg-

Fig. 38.

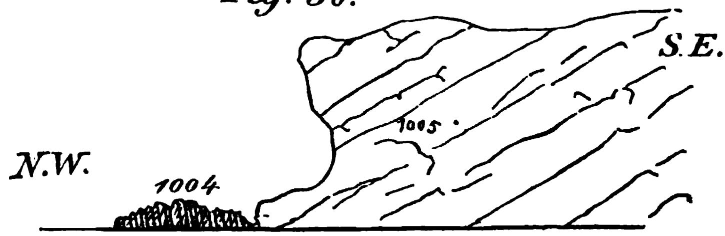


Fig. 38.—*Bluff west of Kawasachong falls, south shore of Fall lake.*

ular coarse bedding that dips about N. W. at an angle of 30° from the horizon. This can not be seen here to overlie, nor to pass into, the rock near the water (1004) but it is possible that the rock near the water is only a rotted and disintegrating condition of that in the upper part of the bluff. There is a greater difference in the outward prevalent structure than in the mineral composition.

At the sharp point projecting southwestward, a little further southwest, but near the centre of the same section, is an interesting exposure which seems to shed light on the nature and origin of the rock forming the Kawasachong falls. A rock which resembles the schist No. 1004 occupies the lake shore nearly all about, at the water level. But at, or near, the extremity of the point, on the north side, the rock which forms the falls of the Kawishiwi, and which seems to be continuous to this place in the uplands, appears in the form of a dike rising through those schists, the contact on the south side of the dike being plainly visible. One is crumpled schistose, fine-grained, hardened, the schistose structure running N. N. E., at an angle of about 75° from the horizon; and the other is coarsely jointed, the main jointage system being, as stated before, at an angle of about 30° from the horizon. The colors of the two approach the same tint of doleritic green, and the hardening action of the dike is perceptible for some distance on the schist. The sketch-map on next page (Fig. 39) shows the relative position of this dike, and the shape of the joint formed by it.

One of the interesting points about this exposure is the widening of the area of the eruptive rock toward the east, by means of overlie on the schists. This is inferred to have taken place at other places, notably on the jaspilyte near the head of the rapids from Garden lake, as shown by Fig. 37, but at no place has the actual contact and overlie been seen so boldly exhibited as at the place indicated on the map.

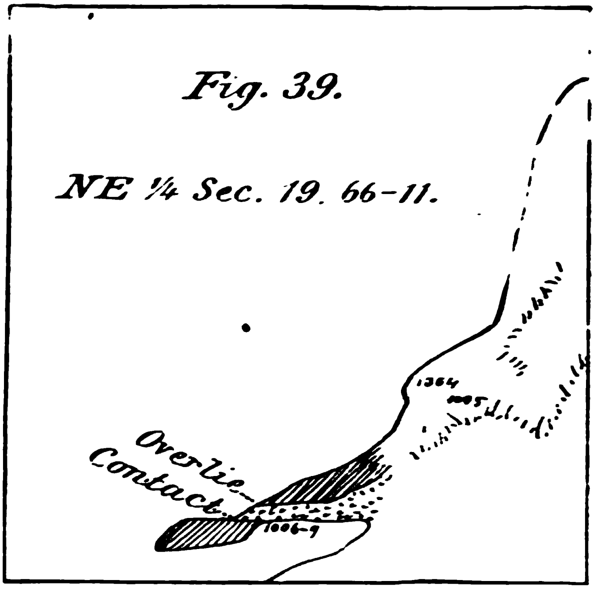


Fig. 39.—*Sketch-map of a point on the south shore of Fall lake.*

A cross-section of the point, showing this overlie, would be about as represented by Fig. 40, the observer looking about N. E. The line of contact, and of change of structure is not so abrupt as the figure indicates, the eruptive rock being welded on the schists, the schists becoming diabasic, and making a rock similar to that which is seen on the eastern branches of the

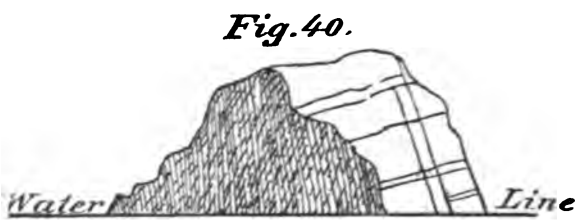


Fig. 40.—*Overflowing dike-rock lying on schist.*

Kawishiwi where the same conjunction of geological features is exhibited. The entire transition, excepting the general hardening of the schists, is completed within the space of an inch, or even less. Indeed on close inspection it is apparent that a mere film, or a line only, evident on the face of the bluff by a thread-like groove, separates the two rocks in many places.

No. 1006 represents the schist near the dike.

No. 1007, small specimen of granular quartz with pyrite disseminated, got in contact with 1006. There is very little of this. It is evidently due to the effect of the dike on the rock through which it comes.

1008. Obtained two feet from the dike, on the south side.

1009 is a sample of the dike-rock.

1010 represents the contact, containing some of each rock, at the place represented in Fig. 41. But this specimen does not fairly show the flowage structure in the diabase. It is difficult to get a specimen containing all the characters.

Parallel with the line of contact, in the diabase, the weather brings to light what might be styled properly a flowage structure, while the schistose structure is continued in the schists squarely up to the line of contact, the two systems of lining making an angle, at the contact line, of about 20 degrees as in Fig. 41.

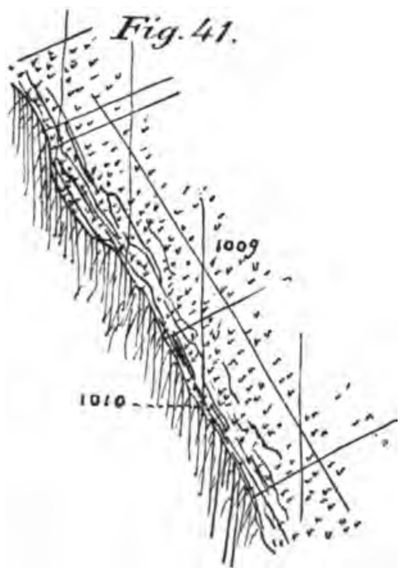


Fig. 41.—*Showing the line of contact of the dike-rock of Fig.* 39 *on the schists, and the flowage structure in the dike.*

The flowage structure in the diabase extends indistinctly sometimes about three inches from the line of contact. It is made visible on the weathered surface by the more rapid whitening of one of the constituent minerals (probably a triclinic) which

for some reason was disposed along the contact in somewhat greater abundance in thin parallel lines.

This is probably but one of the smaller outlets for the igneous rock seen at Kawasachong falls and further south and east. It forms a great stratum, lying unconformable on the schists here, apparently descending toward the valley of Fall lake. Whether it was contemporaneous with the trap-rock of the Cupriferous, remains to be seen by further investigation, likewise whether it is older or more recent than the gabbro rock of the Mesabi range.

A trail passes south from the bay in sec. 19, 63-11, to the head of the bay extending from Garden lake into sec. 30, 63-11. In the S. E. ¼ of sec. 19, is a hill, which is broad and heavily timbered, and at various places near the top are outcrops of jaspilyte, but whether they are transported masses from the main range further south, now embraced in the igneous matrix which forms the main rock of the hill, or are themselves a part of the rock *in situ*, could not be learned from any observations made. The jaspilyte is more nearly a black banded magnetited quartz schist. At one point some surface working has been done, but there is shown no dip or strike, simply a breccia of quartz-schist cemented by quartz veins. The rock of the hill on which this occurs is represented by No. 1011, which was seen at a number of places in small outcrops between the lake shore and the top of the hill. It is essentially the rock that forms the Kawasachong falls.

The quartz-schist last mentioned, containing veins of silica, is cemented in the form of a breccia. The quartz in these veins has the appearance of being "chalcedonic," like the quartz interleaved with the jaspilyte at Tower, and, on disintegrated angles projecting beyond the rest, it shows a similar granular structure. This may show that this was a breccia earlier than the deposition of this (supposed) sedimentary quartz, or that the white granular quartz at Tower is not sedimentary. Sample 1013 shows these veins of chalcedonic silica.

On the trail running south through sec. 19, 63-11, after passing an irregular elevation that seems to be made up of igneous rock, and then a low space, there intervenes another ridge made of a coarse greenish gray rock resembling a modified graywacke of a rather fine grain, No. 1014. This is but little south of the section line between 19 and 30, and to the west of the trail. It rises about fifty feet above the trail. This rock seems to vary toward

the rock that makes the falls of the Kawishiwi. But this variation is due probably to the action of that rock upon it when the two came into contact at the time of the eruption of the molten rock.

At the lake shore in the N. E. ¼ of sec. 30, 63-11, is rock No. 1015, which is identical in mineral character with the last. This is found where the trail from Fall lake reaches the bay in sec. 30, and shows its sedimentary origin more evidently than further north. It is fine-grained, brecciated, rising in a rough and coarsely jointed manner in hills about 50 or 60 feet above the lake, and extending in a series of short, overlapping ridges westward, rising a hundred or a hundred and fifty feet above Garden lake.

About throuhg the centre of sec. 30, 63-11, runs a series of ridges, showing more or less of jasper-hematite (1016). Their direction is ten degrees south of west. This range is on the south side of the hills mentioned (1015), and they show a crumpled and broken banding of iron and jasper, the latter being sometimes red, but never having, so far as seen, a persistent dip or strike. Several parties have located land for iron-mining in this section.

At one point, east of the centre of the section, the bands of jaspilyte have a direction N. 60° E. over quite a large area. It is associated with a greenish wackenitic rock which seems to be worthy of the name of porodyte in some places. This doubtful rock lies both on the north and on the south sides of the ore. It is not, however, apparently conglomeritic.

This ridge or series of ridges continues, with about the same hight, west into the next township, veering a little to the south, passing through the south part of sec. 25, 63-12, into secs. 35, 34 and 33, but the same kind of rock (1002 and 1003) widens out toward the north reaching as far as the shore of Long lake in sec. 28, 63-12, where it presents a rough and broken aspect. It is difficult, in the field to distinguish rock represented by 1002 and 1003 from 1014 and 1015, and still more difficult to distinguish it from 1004 and 1005. It is hardly sericitic; it is flinty or felsitic. It is in huge angular mass or blocks. These have a schistose direction, but no sedimentary banding is apparent. On the trail from the shore of Long lake, sec. 28, 63-12, to Patterson's trenches, S. E. ¼ sec. 28, 63-12, this rock forms a ridge that rises about seventy-five feet, similar to that mentioned in sec. 30, 63-11. The trend of the schistose structure, in sec. 28,

63-12, is apparently northeastward. It acquires silica in lenticular sheets, and in small nodules, as well as having it finely disseminated through the mass, somewhat in the manner of the green schists at Tower. It also becomes flinty, or finely felsitic, though all the time of an olive-green, or greenish-gray color. In some places it looks some like the well-known graywacke, of Vermilion lake, but it is not arenaceous like that, nor bedded in regular sheets. Its analogue at Vermilion lake, if it have any there, would be found in the porodyte in the north side of Stuntz island. It is not always brecciated, and in irregular angular masses, such as represented by 1002, but is sometimes inclined to be schistose, or perhaps slaty, as shown by No. 1003, got about midway between Long lake and Patterson's trenches.

About Garden lake. The island in sec. 20, 63-11, near the outlet of Garden lake, consists of the same rock as that at Kawasachong falls,—a green disabase, but has some of the schistose structure due to disintegration that is visible at the falls. But the greater part of it is entire, or massive. Similar rock extends along the shore of the lake southwest from this island, nearly to the bluff at the head of the bay in sec. 30 where it gives place to a changed graywacke (1014), as already noted. In one place, on the north side of this long arm, about in N. W. ¼ of sec. 29, 63-11, this is so much changed by, and mingled with, diabase that it does not differ much from the diabase. The most notable difference is in having a pinkish-red, weathered exterior, in some small areas, and in being porphyritic and quartzose in others. It has a streamed, or flowage structure in narrow belts that surround lenticular, structureless areas from six inches to twelve inches in diameter.

On the point on the south side of the lake, in the S. W. ¼ of sec. 21, 63-11, is black, or red, jaspilyte, so far as visible mainly in loose pieces, but so abundant that the bed-rock must be near. These are under water except at very low stage. The black, magnetited condition of this jaspilyte is less able to resist frost and weather, separating in curving and conchoidal sheets parallel with the bedding.

There will be some difficulty in separating by mapping, if not by obvious mineral characters, the changed graywacke seen about the west arm of this lake and elsewhere, from the diabase. I can not do it in the field with satisfaction. It will require a more careful study of the specimens collected. Still this belt of rock so indefinite is not very wide. It pertains to the contact

phenomena. There is a wide distinction apparent between the typical rocks, and sometimes these differences are brought into abrupt contrast by a sudden transition, but it is usually not so. The transition is usually gradual, the more enduring, noticeable distinction being a lighter green color, and a siliceous aspect in the wackenitic rock, i. e. an acidic character, and a dark-green or basic character in the diabase.

About on the section line, between secs. 21 and 28, 63-11, on the south side of the lake, just south of the little point at which appear the foregoing detached fragments of jaspilyte, is an exposure of green diabase over which one may walk, on a glaciated surface, for a distance of fifty or sixty rods. This is at the level of the lake, and is partly flooded when the water is high. Here can be read a very instructive lesson in metamorphism. There is a transition, under the varying influence of the lake at higher or lower levels, and the slight difference in crystalline texture at different places, on the same rock surface, from nearly a massive doleryte to a green chlorite schist. The gradations in structure, color and mineral character are indistinguishable from foot to foot over the surface, but the extremes, exhibited at the opposite ends of the uncovered rock-beach, are so great that one would hesitate, without such ocular demonstration, to admit that they are different conditions of the same rock. Perfect facility here is afforded for the inspection of every inch of this rock-surface. This is the doleryte (or diabase) that has been referred to as lying unconformably on the jaspilyte, and as constituting the rock at the falls of Kawasachong. It here changes to a green chlorite schist, and recalls at once the green schist seen to have the same relation to the jaspilyte at Tower. It almost demonstrates the eruptive origin of that green schist.

1017. Green schist with disseminated striated crystals of white calcite that rapidly effervesce in acid, and some granular (?) quartz, such as seen in the green schist at Tower, in small lenticular patches. From the foregoing outcrop N. W. ¼ of sec. 28, 63-11.

1018. Similar schist, from the same exposed surface but showing no white crystals; same place.

1019. Similar schist, less schistose; same place.

1020. Similar rock, hardly schistose; same place.

1021. Similar rock, but evidently changed from an igneous rock; same place.

1022. Changed doleryte; same place.

1023. From the midst of the very schistose parts (1017-1018) showing a preservation of firmness and massive structure in some places; from the same place.

The strike of the schistosity is E. 23½ degrees N. and vertical. There is no banding of sedimentary structure in this rock.

On an island about three-fourths of a mile further east, in the bed of the river, the strike of the schist is E. 15 degrees N. It here verges more evidently toward the Kawasachong falls rock.

At Quinn's, N. W. ¼ of sec. 27, 63-11, among the boulders of granite, etc., are some of jasper and hematite. The rock in outcrop is diabasic, apparently belonging to that last mentioned, though weathering rather light-colored, and in that respect resembling the modified graywacke.

At Julian Bausman's, S. W. ¼ sec. 23, 63-11, is a good showing of iron, though visible in several isolated outcrops, and at no place in large amounts. It is not worked yet, nor uncovered. It is probably in the range of that noted in the S. W. ¼ of sec. 21, 63-11, and appears like it. Mr. Bausman says it is traceable, by needle mainly, being magnetic and rather black-red, through the rest of this section and eastward. Rock No. 1024, obtained at Bausman's, S. W. ¼ of sec. 23, 63-11, is a somewhat schistose magnetic iron ore. This does not show the usual character of the ore here, so far as can be seen, but one of the forms it takes.

This sample gives:

Iron	47.07 p. c.
Titanium	traces.
Chromium	none.

In sec. 21, 63-11, according to Mr. E. Byrne, a ridge of black jasper and magnetite, or two of them in one place, extends from near the east side of the section nearly due west, becoming involved with, or "covered by," at least replaced by, a quartzose poroditic rock, No. 1 (H) and No. 283 (W). After an interval of about 150 feet of this rock, the same black rock recurs, and extends westwardly. It is next seen further south, where it constitutes a distinct ridge, and is traceable through two-thirds of sec. 21. This iron ore is represented by No. 1025. This iron range seems to continue, with more or less interruption, through secs. 23 and 13 in 63-11, and appears also in the next town east.

On the N. W. ¼ of sec 28, 63-11, a diabasic green rock (949) cuts a greenish, hard, finely schistose rock (948), the contact being well exposed on the south side for a distance of a few feet. A schist somewhat resembling this, but more nodular, and more like an igneous breccia of schist and diabase, forms a small island in the S. E. ¼ of sec. 20, 63-11. It dips south, but stands nearly perpendicular.

At the lower end of the rapids which are formed where White Iron lake descends to Garden lake, N. E. ¼ of sec. 32, 63-11, are two short, small tunnels, running in opposite directions, into a siliceous schist or bedded quartzyte, which disturbs the compass needle by magnetic attraction. It dips N. N. E. 80°-85°. It is somewhat brecciated, and recemented by chemical silica and pyrites. In some places this bedded quartzyte is black, and in others blue, sonorous and brittle, recalling the Animikie quartzytes. It is represented by 950. The quartz in which the tunnels were excavated is represented by No. 951. This locality is known locally as *Silver City*, so named by the proprietor of the tunneling.

At the upper end of the rapids which run north from White Iron lake, the rock is micaceous magnetic quartz-schist, dark colored, becoming greenish. On the west side, near the level of White Iron lake, a dike of greenstone cuts these schists, running about east and west, the contact being plainly visible, the change of the rock being abrupt. In some large loose pieces of the magnetic schist, lying near the dike, it is seen to become garnetiferous, and also has pyrites cubes. The beds here stand nearly vertical.

In the northern part of sec. 32, 63-11, on the west shore, the diabase schist is igneous, resembling much that can be seen in the Cupriferous.

Notes on White Iron lake. The syenite along the west side of White Iron lake, in sec. 6, 62-11, is represented by No. 952, which is coarse, weathers red, appears like an eruptive rock, has contact with a changed "gabbro" on the east side of the lake (about centre of sec. 12, 62-12) and extends south. The trail which passes eastward from White Iron lake to the river in sec. 19, 62-11, passes over immense and numerous boulders, most of them being of coarsely crystalline syenite, the feldspar being porphyritically distributed (953). The river evidently sometimes floods much of this trail, and keeps the stones free from soil and vegetation. This rock is in place near the east end of

the trail, and at the river bank, and extends northward causing the foaming rapids through the N. W. ¼ of sec. 19. It is everywhere homogeneous and massive. Several islands in White Iron lake, in the north part of sec. 24, 62-12, are made apparently of this rock.

As to the age of the syenite about White Iron lake, compared with that which is associated and interstratified with the mica schist, seen on the northern side of Vermilion lake, there is, at present, no certain datum on which to base an opinion. Its genetic relations have not (now) been made out, and its geographic position and stratigraphic associations are the only guides. It is disconnected from the other area by lying further south, separated from that by a belt of greenstone, quartzytes, schists, argillytes and mica schists. Its associations are not very different. Veins or dikes of it are seen running through the doleryte along the west side of White Iron lake, in a manner analogous to those seen in the hornblendic-mica-schist series on the north shore of Vermilion lake. By Dr. Wadsworth, as described below, it cuts mica-schist and quartzyte near the northern limit of its area, at the north end of White Iron lake, on sec. 32, 63-11. The east shore of White Iron lake was examined by Dr. Wadsworth from the foot of the lake to the southern extremity, and his notes are given below.

Dr. Wadsworth's notes on the east shore of White Iron lake:

The island in this lake lying in sec. 33, 63-11, and in sec. 5, 62-11, is granite. However, no solid granite could be found in place, but the fragmental portions had evidently been formed by the breaking up of a granitic mass, and they were in place or nearly so (1110).

At the foot of the lake or its northern end the rock is a schist which can be styled, owing to its varying composition, in different portions quartz, hornblende or mica-schist, ètc. This rock stands nearly vertical or with a slight dip from the vertical towards the north. The strike is southerly or to the east of south. In places the schist is ferruginous, the ore being principally magnetite. Although this schistose formation is sedimentary and unlike the lake Superior iron ore formation, yet it will doubtless be compared by most geologists with the latter, as it in places shows similar bandings and contortions. Yet in my judgment the two formations are utterly unlike. This schist has evidently been altered by a hornblendic granite which has been intruded through it; which intrusive rock is doubtless the cause of the induration and contortion of the schist and for its ferruginous material becoming magnetite.

Nos. 1111, 1112, 1113, 1114 and 1115 represent different forms of the same schist, while No. 1116 is the granite at some distance from its contact with the schist, and is the same as the granite of the island (No. 1110) and elsewhere about the lake.

Nos. 1117, 1118, 1119, 1120, 1121 and 1122 are junction specimens of the granite and its contact with the schist. Nos. 1123 and 1124 are portions of the schist which have been more indurated and altered by contact with the granite. These specimens were taken low down on a cliff, while all the other contact specimens were taken higher up on the hillside except 1122. As the contact line was followed up the hill the schist is found to be less indurated. No. 1125 is a portion near the lower contact (1123) which still shows the schist banding and it is cut by two granitic veins.

No. 1126 is a portion of the edge of the granite at the contact, which is filled with fragments of schist. The schist extends southwardly on the lake shore, with some intermingled granite intruded through it, for about half a mile.

It is quite difficult to ascertain the strike by the compass owing to the magnetite in the schists. No. 1127 is a specimen of the contorted schist with magnetite. On a point marked on the map occurs the gabbro (No. 1128) cut by the intrusive granite (1129).

No. 1130 is the contact of a dike of this granite, with the gabbro through which it is intruded. No. 1131 also shows contacts of the granite and gabbro. The gabbro mass follows the lake shore on a bay and trends southerly or to the east of south. It is coarsely crystalline, much altered and micaceous, and would be called by name a minette. Fragments of the gabbro are inclosed in the granite.

On the "meander" line between secs. 6 and 7, 62-11, granite *in situ* occurs extending both north and south of that line. South of the line a little black hornblendic gneiss (No. 1132) was observed cut through and through by the granite. This granite extends in a ridge running west of south (40°) into the interior. All the granite is cut by dikes of micro-granite (1133).

Some micaceous gabbro* (1134) is seen on the lake shore in sec. 12, 62-12. This gabbro is cut through and through by the granite. The rest of the east shore of the lake to the point where the main stream enters from Birch lake is granite, and most of the way the rock is in place. In some places the granite is cut by a dark hornblendic rock (No. 1135) in irregular but small dikes. The granite closely resembles the so-called Laurentian gneiss. It shows banding or foliation and contains fragments of schist. The banding is here regarded as a foliation caused by fluidal structure; while others think it to have been produced by sedimentation.

On the ridge between the lake and its inlet numerous boulders of altered gabbro (dioryte) were observed cut by dikes of granite.

Birch river and Birch lake. The further notes of Dr. Wadsworth, on Birch river and lake, are as follows:

Following up the river from White Iron lake toward Birch lake granite in place or in boulders was observed to extend all the way to the line between sec. 31, 62-11, and sec. 6, 61-11. At this point the granite is in place, and it was found to extend on the west side for about half a mile into the unsurveyed

* The rock which Dr. Wadsworth here styles gabbro is a part of the mica-hornblende-schist series. It may have been originally a gabbro, but it is not connected with the great gabbro overflow which is uniformly meant when gabbro is spoken of elsewhere in this report, but must have been of much earlier date. It is that which, at the west end of Birch lake, is noted as varying from hornblende schist to mica-schist, and is there in the same way cut by dikes of "granite."

T. 61. Here gabbro (1136) appears. This is much less altered than the preceding gabbro observed, and it bears much well-marked feldspar. From this point the gabbro extends all the way on the west side of the lake until the lake passes out of T. 61-11 into 61-12 at the secs. 30 and 25. A short distance to the west of meander stakes between secs. 24 and 25, 61-12, the gabbro becomes fine-grained and appears as if it ended as a fine-grained diabasic looking rock, (1137).

Just beyond this are seen fragments of a peculiar rock resembling an indurated sandstone or schist, and containing much magnetite (1138).

To the east of the meander corner, between secs. 23 and 24, the granite was found in place. This, like much of the granite previously observed, contains porphyritic crystals of red feldspar. No. 1139 was found in place just west of the same corner.

Here some boulders of schist cut by granite were seen.

About ⅛ of a mile west of the corner above given, the granite was again found in place and is of a fine-grained texture like a micro-granite (1140). The concentric jointing shows excellently well in places.

On the east side of Birch lake, about N. W. ¼ of sec. 20, 61-11, is a perpendicular bluff of coarse gabbro rising about 32 feet above the lake, having large rhomboidal fallen masses lying at the foot. It faces west, and shows on the perpendicular wall a coarse-bedded structure, brought out by the grooves that run across the wall produced by unequal weathering. These dip toward the south, at an angle of forty degrees from the horizon, the large grooves being from three to five feet apart, but sometimes having more frequent finer ones between them. The following sketch (Fig. 42) illustrates this bluff, in a rough way. The grooves are very regular, but some of them fade out in passing along.

Fig. 42.

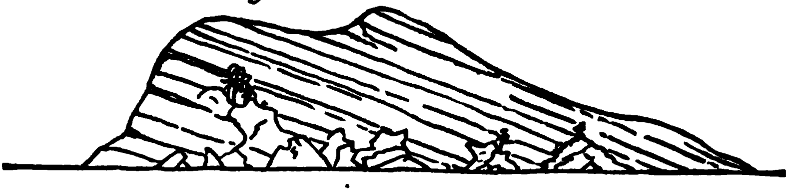


Fig. 42.—*Bedded gabbro bluff, east side of Birch lake.*

These grooves are due to the weathering out of a mineral which happens to have been more abundant in these lines, compared to the other minerals, than in the rest of the rock. This same mineral is found throughout the rest of the rock, though not arranged in gneissic order, and its more rapid disintegration causes numerous small pits over the weathered surface. On

inspection this mineral appears to be olivine; the rock also contains black mica, in amount greater than customary for gabbro. Rock 954 represents this gabbro.

At about the section line between secs. 29 and 30, 61-11, on the south shore, is another perpendicular bluff of gabbro. Indeed numerous nearly perpendicular bluffs, from 30 to 50 feet high, made of this rock, appear at the shore through sec. 30, while on the north shore they are gradually ascending from the water level. This is owing to the prevalent dip of main structural planes of the gabbro being toward the south, or southeasterly.

A curious fact is the quick change in the character of the boulders, as the character of the underlying rock changes. In the syenite region they are mainly of syenite, but where the gabbro begins they immediately become almost wholly of gabbro. The decaying olivine gives a pitted surface to nearly all of the boulders.

Some of the syenite (or granite) seen in boulders in sec. 26, 61-12, has the appearance of gneissic structure, suggesting that part of it may have been derived from metamorphism of sedimentary rocks (955). It is dark-colored, the crystals are imperfectly formed, and crowded, and much finer than in the syenite mentioned seen at White Iron lake. Other parts (seen in boulders in sec. 26) are chloritic and dark-colored (956), and some slabs appear like a micaceous quartzyte, but may be a somewhat changed olivine rock (957).

The little point on the north shore, situated in the N. E. ¼ of the S. E. ¼ of sec. 21, 61-12, consisting of a breccia of mica-schist cemented by granite No. 958, shows the manner of contact. The granite goes generally in all directions, embracing the mica-schist, and also appears as isolated masses. It also runs parallel to the schistose structure, producing a bedded gneiss, which dips about west 75° from the horizon. This is the same as the mica-schist and interbedded granite seen on the north side of Vermilion lake. 958 A, shows some of this mica-schist, while 958 B, shows the nature of a narrow vein or "dike" of the granite, and the full width of it (about ¼ inch), beyond which it continues but gradually diminishes to a needle point, and vanishes in the schist. It is hard to understand how a true igneous dike could thus fade out. It seems to disappear because the mica gradually prevails over the other minerals and converts it into mica-schist, which itself seems to contain only the minerals seen in the granite.

Through the western part of sec. 22, 61-12, on the north shore, only the igneous looking, coarse-jointed syenite can be seen. It is coarsely crystalline, has a bedding structure similar to what can be seen in the trap-rocks of lake Superior, but in the eastern part of the section a fine-grained, red-weathering bedded granite appears, both near the shore and also in a bluff at some rods from the shore. The bluff that faces the lake has the appearance of being an old wall of masonry, the rough, thin layering appearing about as distinct as the courses in a rubble wall when pointed with mortar by the mason and smoothed by the trowel. The beds are from four to eight inches thick, and dip easterly about 5° from the horizon. This granite, which is fine-grained and micaceous, extends eastward from the S. E. ¼ of sec. 22, 61-12, and is represented by 959. The figure herewith (Fig. 43) shows three successive outcrops of granite. *A* occurs on the point in sec. 21, already mentioned. *B* is about three-quarters of a mile further east, and *C* is on the S. E. ¼ of sec. 22. There are three different types. It is yet to be ascertained whether their genesis is the same. Rock 961 shows the contact between the coarse syenite like 953, as it occurs near the S. W. corner of sec. 24, 61-12, and the granite 955 and 959.

Fig. 43.—*Showing three types of syenite.*

Sometimes, in the porphyritic syenite, are bands of fine-grained syenite, running like dikes. Sometimes bands of coarse granite, or granulyte (i. e. orthoclase and quartz) run in the same manner. These last may be of chemical origin.

The relations of these different kinds of syenite, and of granite, are expressed by Fig. 44 which was sketched from the bluff at the S. E. ¼ of sec. 22, 61-12.

Rock 964 shows a coarse syenite, lying on 965, apparently conformably, 964 A is from a vein (or dike) of fine granular granite, six inches wide, running across the bedding of 964 and blending with 965. 964 B is mica-schist, a condition of 964 A, in small patches.

In 964 A is a central band of orthoclase and quartz, about half an inch wide, running parallel with the sides and fading out in about four feet.

Rock 965 is fine-grained granite, in bedded regular dip E 30°. 965 A is from a vein (or dike) of coarse syenite running zigzag in 965.

Rock 966 is the lower coarse syenite. This rises toward the left so as to appear to have been unconformable under 965.

It might be presumed that the massive rock (966 and 964) wherever it occurs in this country is igneous, and 965 is of sedimentary origin. The above figure, however, with the veins that run from 965 to 964, and similar veins seen in the coarse syenite in numerous other places, seem to indicate that these rocks have a common origin. The fact that 965 becomes gneissic with mica, and alternates with mica-schist, thus apparently parallelizing the granite in the N. W. part of Vermilion lake, indicates that this syenite and granite are on the same (Laurentian) horizon as that. What relation this has to the granite seen cutting the doleryte on the west side of White Iron lake is uncertain, but on the north shore of Birch lake the facts, so far as seen, indicate that the gabbro lies on the granite.

Fig. 44.

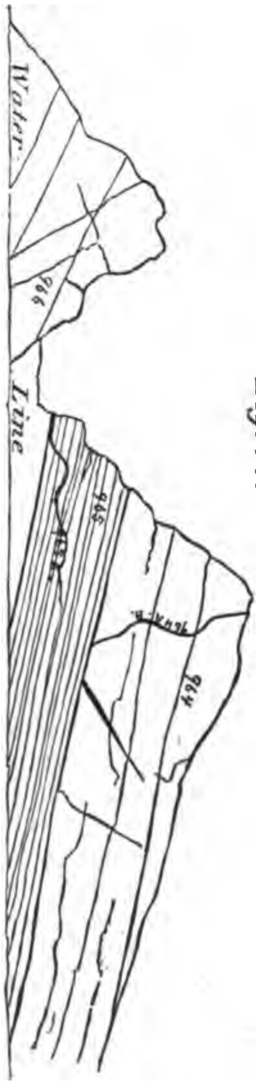


Fig. 44.—Superposition in syenite masses.

On the S. W. ¼ of sec. 24, 61-12, about a quarter of a mile east of the line dividing the syenite from the gabbro, is a low ridge, about fifteen rods from the shore, composed of a ferruginous olivine rock which is magnetic, and really constitutes an olivinitic iron ore (960). The rock appears under the moss and trees in irregular loose pieces, evidently in

place. The iron in this ore gave (when the fine-grained portions were analyzed by themselves) 54.1 per cent. It contains no titanium and no chromium. When the coarser crystalline parts were examined by themselves the iron amounted to 51.30 per cent, without titanium and chromium. This rock is the same as No. 1138, which was obtained from the same place by Dr. Wadsworth. Large boulders of the same ore are on the beach near this place.

At another point on the beach, about a quarter of a mile further west, is a small exposure of olivinitic gabbro, the rock being dark-colored, the augite being changed apparently to a large extent to mica, and the olivine being rusty. Very near this place, but lying to the west of it, and indeed almost in contact with it, is a large mass of fine-grained granite and such stone makes the boulders of the beach. This must be very near the contact line, as these large pieces form almost a continuous rock surface, broken only by opened jointage and covered somewhat by smaller blocks.

The point at the section line between secs. 23 and 24, 61-12, on the north side of Birch lake, is made of porphyritic syenite, like No. 953, but a little east of the point a few rods back in the woods, is a small ridge of fine-grained red syenite, resembling the "red rock" back of Grand Marais. It is represented by No. 963, and it lies in a position similar to that of the fine-grained rock 959.

Mr. Grant examined the bay in secs. 21 and 16, 61-12. He found on the north side of sec. 21 the rock 967, in the form of a vein (or dike) cutting coarse syenite. It is evidently a decayed or changed syenite, some of the hornblende having been replaced by an epidote-like mineral and some changed to a greenish-silvery, foliated, chlorite-like mineral, by far the greater part being rather coarse, pinkish orthoclase. At another point, north of the section line, on the west side of the bay, he met with a coarse syenite cut by a two-inch vein of fine syenite. This coarse syenite shows the hornblende is passing to mica. (See sample No. 918.) In other places has been noticed a mingling of black mica with hornblende in the coarse syenite. Sometimes, also, in the gabbro the olivine is embraced in the central part of the augite crystals. No. 968 represents the rock mentioned above where hornblende is so associated with black mica that it seems to pass into it, the rock being cut by a two-inch vein, or band, of much lighter-colored, or reddish, fine syenite. Both rocks are very quartzose.

An isolated rock, in place though, stands up in the water, in the bay, in the S. W. ¼ of sec. 28, 61-12, exactly like the mixed mica-schist and granite described on the point in the N. E. ¼ of the S. E. ¼ of sec. 21, 61-12. It here dips N. N. W. 75°-80°.

A dark dike, eighteen inches wide, runs N. E. and shows on the face of the coarse syenite, descending to the water, in the S. E. ¼ of sec. 29, 61-12. Sample 969 is so taken that it shows the contact with a thin transverse vein, that crosses this doleritic dike, of feldspathic rock which seems to have been deposited chemically in a fissure in the dike, as it is not connected with the adjoining syenite. The following figure shows this. (Fig. 45.)

Fig. 45.

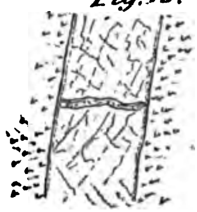


Fig. 45.—*Feldspathic vein crossing doleryte.*

This dike, which consists almost wholly of hornblende where sketched above, changes gradually to mica-schist (970). No. 971 shows its contact with the wall of syenite, the dike here being changed entirely to mica-schist.

This change in this dike seems to indicate that other local appearances of mica-schist in this syenite, such as that seen on the point in the S. E. ¼ of sec. 21, 61-12, may be ascribed to the changed condition of an igneous rock, such as this undoubtedly was. In this mica-schist, thus changed from some igneous rock, there is a superabundance of mica, and the white ingredient is not certainly quartz.

At a point a little further north from this dike, on the same section, is a promontory of gneiss, the rock being striped with the gneissic structure, the striping dipping south 85°, but being somewhat contorted. Some of this rock is fine-grained, hard quartzose, granite, and in it occasionally are nodules of mica-schist, resembling the rock 970. This gneiss is represented by No. 972.

This gneiss continues westward to the town-line between 61-12

and 61-13, but is rather less distinctly banded, or bedded, than a typical gneiss, and instead coarsely fibrous in a direction coincident with the supposed prevalent dip, the coarse bars or contorted sheets, whichever they may be styled, showing a striation, or schistose structure seen from different directions, and sometimes manifesting the same illusory dip as seen in the dark gneiss or mica-schist, mentioned in the N. W. part of Vermilion lake. As a gneiss it is very irregular. It is more correctly an irregular alternating of two rocks than a gneissic arrangement of minerals, though the latter structure can also be seen in some large patches. The rocks so alternating are syenite, fine syenite, fine granite, micaceous granite, and mica schist.

On careful examination over contiguous and continuous surfaces, the mica in this rock can be seen to be replaced by hornblende, and then it becomes dark, firm and dioryte-looking, but still twisted and contorted with a light-weathering syenite, and often mingled with a true granite of fine grain. In short, there seems to be a transition from mica-schist, as before surmised, to hornblende schist, this change taking place according to the less or greater exposure and disintegrating action of the elements. (Compare 1134.)

The manner in which this dark rock incloses parts of the lighter rock will allow of its being originally an igneous rock. On the other hand, the manner in which the syenite acts, with respect to the mica-schist, seems also to allow of its having been an eruptive rock.

No. 973 shows this rock in its hornblendic aspects. These (two) specimens were obtained from near contact with white-weathering, fine-grained, mica-granite, or gneiss, the latter being in strings, blocks and masses of all positions and shapes.

No. 974 shows this rock undergoing a change toward mica-schist.

If this mica-schist be a changed igneous rock, it should contain, theoretically, no original free quartz, and thus perhaps, as well as by some other characters which may be discoverable, it may be distinguished from the bedded sedimentary mica schist such as in the N. W. part of Vermilion lake passes into granite conformably.

Where Birch river enters Birch lake, in sec. 25, 61-13, the outcropping rock on the north side of the river is syenite and gneiss, dipping N. E., while through secs. 19, 20 and 29, 61-12, the dip is almost invariably in a southerly direction (S. or S. S. E.),

varying from 45° to 80°, further south, also, in secs. 25 and 36, 61-13, the dip is about south, and the rock, nearly everywhere that it is visible, is the same gneiss. But in the southwest end of the lake the rock is more hid by drift, and the shore-line consists of boulders and sand. A broad bay in sec. 36, 61-13, has a wide sandy beach.

This mottled schist is again represented by 975 (two samples) got at the extreme west end of Birch lake, near the head of the bay south of the mouth of the river. The samples are dark-colored, but the face of the bluff from which they came, sometimes about half of it, is light-colored. The rock seems to have been in some places originally a fine-grained dioryte, the feldspar not being individualized, but in others to have been fissured and the fissures filled with chemically deposited quartz and orthoclase.

The round point in the N. W. part of sec. 31, 61-12, is made up of a syenite which in some places shows the same gnessic structure, the latter being in narrow bands dipping south and in isolated included pieces. These patches are micaceo-hornblendic. This structure seems to gradually become less and less common in this direction (i. e. easterly), and to be most prevalent in the N. W. part of the lake.

The syenite in the N. E. ¼ of sec. 31, 61-12, is massive but embraces lenticular, elongated and irregular masses of fine-grained quartzose reddish granite, and the same also in veins. I notice that the hornblende grains have their elongation in the direction of the hitherto prevalent strike, producing a kind of structural arrangement that can be compared to that of gneiss.

There is an accumulation of fine, black, feebly magnetic sand on the beech at the S. W. ¼ of sec. 33, 61-12, near the mouth of a little rivulet. This probably is derived from the disintegration of some olivinitic iron ore at a short distance from the beach, similar to that seen on the north side of the lake (960). This sand, on analysis, gave the following result:

Silica	5.19
Metallic iron	41.12
Titanium dioxide	36.77
Alumina	2.95
Lime	trace.
Magnesia	35
Phosphorus	none.

Drift deposits cover the rock from this point northeastward

to the S. E. ¼ of sec. 28, 61-12, where the rock 978 outcrops conspicuously on the shore. It is a coarse, dark-colored dioryte, but shows the hornblende changing to mica, the mica scales originating within the hornblendes transverse to the fibrous grain of the hornblende. A short distance to the south of this the rock is gneiss, though on the north side, near it, but disconnected, is a similar outcrop of coarse syenite. Some of the last weathers red, and some light-gray. At the next point, north, is a still more conspicuous exposure of coarse syenite veined by finer red syenite.

Dunka river. At the mouth of this river the beach is one of sand, having a reddish aspect resembling that of the red beach at the mouth of the Brulé river east of Grand Marais. This color is also due to the same cause—the distribution of a red stone by the lake, and through the action of the river. Further, it is the same red stone—the "red rock" of the Cupriferous—which is here in pebbles not larger than an inch, and generally less than half an inch, in diameter, mingled with some of the same sizes, of granite and syenite.

There is a drift plateau bordering the lake along here, for a mile or two and ascending the Dunka valley, rising from 75 to 100 feet above the lake, making a fine expanse of farming land, now covered by a forest of mixed pine and deciduous trees.

The drift is, so far as can be seen, fine and clayey, and furnishes the beach with its materials. It dates back to the glacial age. It shows, by its composition, a northward transportation down the Dunka valley, and an extension of this movement from a point far enough south to bring rocks of the Cupriferous to the shores of Birch lake.

The river can be ascended by a canoe about half a mile, although there is a copious delta accumulation at the mouth, consisting of sand, which extends far into the lake, producing so shallow water that a small bark canoe drags on the bottom when carrying two men. The Indian winter trail, which leads to Beaver bay on lake Superior, leaves the right bank of the river near the town-line between 61-12 and 60-12, and it can easily be followed as far as we went, and probably all the way to lake Superior. It is obstructed by numerous old pines and poplars thrown down by the wind. It crosses the river in S. W. ¼ sec. 10, 60-12, and again in sec. 15, next south, and then bears more easterly. The country through which it passes is chiefly drift covered, and holds considerable good pine, though chiefly Nor-

way averaging 16 to 20 inches in diameter. Ten years' growth will make it very valuable.

After passing the main drift ridge, which rises by aneroid, 120 feet above Birch lake and ceases in N. W. ¼ sec. 10, 60-12, there succeeds a series of piles and ridges of granitic boulders, the syenite appearing *in situ* about on the half-section line in sec. 10, where the trail crosses it. At a point a little further north appeared numerous ferruginous olivinitic iron boulders (976). These are so numerous that it is evident that the low ridge on which they occur must contain a deposit of iron of this kind. These boulders show on analysis no titanium. At the crossing in sec. 10, where the river is 110 feet above Birch lake, the right bank is of drift, and rises forty or fifty feet above the river, the flood-plain being about five feet above the low-water stage. The water runs on fine-grained olivine-bearing gabbro rock (977) or "muscovado," containing biotite, and descends rapidly below the crossing. The prominent high ridge which is visible from the lake, rising several hundred feet higher, crossing S. E. ¼ of sec. 7, the whole of sec. 8, and ceasing in sec. 9, 60-12, does not reach the Dunka river, but seems to be reduced to the low syenite ridge which appears in the trail N. W. ¼ of the S. W. ¼ of sec. 10. The gabbro seems to lie to the south of this ridge, a small hill of it rising on the west side of the river not far from the crossing.

It was much to our regret that the rainy weather, and the limited time at our command, prohibited a visit to the great ridge in sec. 8, 60-12. From other information, however, this is supposed to consist of syenite, and to constitute the eastern end of the range which is known further west by the name of Grant's range.*

East branch of Birch river. Kawishiwi river, in coming from the east, through towns 63-9 and 10, divides in sec. 26, 63-10, into two parts, the principal amount continuing westwardly through 63-10 and reaching Farm lake, and the other portion flowing southwestwardly through 62-10 and 62-11, uniting with Birch lake in sec. 6, 61-11. This latter portion, with that water which comes from lake Isabella in 62-8, through Bald Eagle and Gabbro lakes, is here included under the name East branch of Birch river. It will be seen that by the aid of Birch river and White Iron lake on the west, Farm lake and Kawishiwi river on the north, this river forms the hypothenuse of triangular

* The station "Messaba Heights," on the Duluth & Iron Range R. R., is on this ridge.

island—an island which seems to be constituted entirely of syenitic rock.

All the way from Birch lake, in sec. 6, 61-11, to the rapids in N. E. ¼ of sec. 27, 62-11, this river covers the line of contact between the gabbro and the syenite, indicating the existence there, for some reason, of a more erosible rock. At these rapids the water channel jogs suddenly to the north, though there is an extension of the bay northeastwardly in the probable direction of this contact horizon from sec. 27 into sec. 26. This is hypothetically the horizon of the ferriferous olivine rock. Further northeast, in secs. 23, 24 and 13, 62-11, this stream lies on syenite, and expands into Copeland's lake in the north part of sec. 24. In this stream rapids occur at the N. E. ¼ sec. 27, 62-11, ascending 16 feet; S. E. ¼ of sec. 22, 62-11, ascending 3 feet; S. W. ¼ of sec. 23, 62-11, ascending 5 feet; in the north part of sec. 23, 62-11, ascending 5 feet; in the N. E. ¼ of the S. W. ¼ of sec. 24, ascending 5 feet, and at the foot of Copeland's lake ascending 6 feet. Syenite prevails all the way up this water-course, through the whole length of Copeland's lake. It is generally coarse-grained and even phorphyritic with orthoclase crystals ½ inch across, sometimes these reaching 1½ inches across. But a fine-grained syenite is distributed through this rock very capriciously. It occurs not only in beds but in dikes and veins.

At the north end of Copeland's lake a change takes place. There is a dike running apparently N. N. W. from the little bay in the N. E. corner of sec. 7, across the river, probably being the chief agent in determining the location of the rapids at the head of Copeland's lake. It cuts through syenite. On the east side of this is much confusion in the character of the rock. Sometimes it is gneissic syenite, not porphyritic. Sometimes it appears to be diabase in limited areas, and sometimes apparently a dioryte, and again a fine-grained syenite, and a distinct gneiss, the last having a dip N. W. about 80°. On the west shore, running from sec. 6 to sec. 5, 62-10, is a bold and conspicuous, perpendicular wall of fine-grained syenite, but it has a frequent jointage like some igneous rock. A little further east, near the town-line between sec. 5, 62-10 and sec. 32, 63-10, on the west shore of the bay, the underlying rock is a greenstone, firm and tough, and very dark-colored.

The rock of the *Palisades*, which is a name given here to a nearly perpendicular wall of reddish, fine-grained syenite in the S. W. ¼ of sec. 4, 62-10, on the north side of the bay, recalls,

both by its physical aspect, and by its orthoclastic composition, the rock of the Great Palisades, on the north shore of lake Superior. It stands in a rudely columnar and slightly sloping position, rises from the lake level to the hight of forty or fifty feet, and extends along the lake shore about twenty-five rods. Long columns fall away. Yet this rock is the red syenite along here. Elsewhere, also, in the bay in sec. 9, 62-10, and along the bay into which the river flows from the S. W., the same red fine syenite appears. This red syenite (979), which sometimes seems very hornblendic, continues to the gabbro contact, S. W. ¼ of sec. 9, 62-10, where, so far as can be made out, in the timbered and moss-covered condition of the rock-hills, the transition is similar to that seen at Duluth, viz.: by a series of veinings in the gabbro, and a dissemination of red weathering feldspar in it, some patches in the gabbro being real syenite (rather quartzose) but fine-grained. The real gabbro character is established after a few rods of such mixed rock. When the phenomena are all condensed, the impression left on the observer is that the gabbro overlies the syenite, though there is here no such concrete observation.

Mr. Stacy visited an iron locality in sec. 30, 62-10. It is in the midst of gabbro rock, in the west half of the S. E. ¼ of the section, and the exposed iron surface, varying more or less to rock, occupies an estimated area of about thirty acres. The ore is similar to that seen on the north shore of Birch lake, in sec. 24, 61-12, and two analyses show the following results, according to Prof. Dodge:

Coarsely crystalline, magnetic, iron, 48.05; Titanium.................. 2.44
Fine-grained, olivinitic, magnetic, iron, 61.27; Titanium...........none.

Gabbro forms all the shores and islands of Gabbro and Bald Eagle lakes. Through the central part of the town (62-10) runs a very hilly country, the gabbro rising from 200 to 300 feet above the lakes lying to the north. The ridge in the southern part of sec. 22 was visited. It shows in some places large veins, or dikes, of a very coarse gabbro surrounding large areas of very fine-grained gabbro; some of the large crystals supposed to be of augite were collected for preservation. This ridge here rises according to aneroid 185 feet, but at points further west it rises 50-75 feet still higher. The highest elevations seem to be in secs. 19 and 20 of the same town. But the elevation does not consist of a single ridge, with ascent from both directions, but rather of an irregular succession of ridges and hills of some-

what varied shape, the whole presenting, when viewed from the north, the aspect of a prominent and connected line of hills.

We ascended the river toward Isabella lake as far as the supplies we had, the time at command and the frequent rapids would warrant, which was about two miles above Bald Eagle lake, and near the town-line crossing. About two-thirds of this distance the river is wide and smooth. A considerable tributary (the south branch of Birch river) joins the east branch in the N. W. ¼ of sec. 5, 61-9. A long portage and many rapids were to be encountered, further up stream. Gabbro rock continued as far as the examination went, the same as noted in sec. 22, 62-10, forming hills from 50 to 100 feet high along the south side of the river. I walked to the upper end of the portage, and from all that could be seen it was judged probable that gabbro rock continued to and even beyond lake Isabella.

Almost anywhere that any dip can be seen in the gabbro, it shows a coarse-bedded structure that dips southerly, at least away from the area of the syenite.

The fine syenite which extends from the gabbro contact in sec. 9, 62-10, northwardly along the westerly side of the water that runs from sec. 9 to the next town north, and into 63-10, to the fork of the Kawishiwi, sec. 26, is represented by four specimens numbered 979, taken from different places to show its variations. This is, altogether, the same rock as the palisade rock of sec. 4, 62-10. It lies here next north of the gabbro, and apparently under the gabbro, though no large exposure was seen showing this relation—the best being at the Archway rapids,* in sec. 9, 62-10. Here the gabbro has the usual coarse bedding, and the syenite itself sometimes seems to show the same structure and dip, indicating a coarse alternation and grand superposition of parts.

At the gabbro-syenite contact in the N. W. ¼ sec. 25, 63-10, there is no opportunity to learn the stratigraphic relations of the two rocks. The gabbro runs inland from the shore, making a bluff about 25 feet high. Then on the beach, which is low, and boulder-strewn for 15 or 20 rods, are large pieces, some of them probably not much removed from their natural positions, of mixed rock, orthoclase gabbro, syenite veined with fine red-weathering syenite, and some coarse gabbro. These run along to the little point, westwardly, where a fine-grained syenite

* These rapids are so named from an arch of gabbro on the east side under which a part of the water runs, and sufficiently high for a man to pass upright.

appears, mixed with veins and beds of coarse syenite, and with some changed igneous rock, the latter being now a mica-schist —though of this but very little—the whole apparently running below the gabbro.

Kawishiwi river. This river unites with Birch river waters in Farm lake, in the north part of sec. 34, 63-11, and from that point this name is given to the united stream down to the debouchure into Fall lake. The Kawishiwi originates in numerous small streams and lake basins that lie in T. 63-6, the highest principal lake basin being lake Polly, in the southern part of that town. In the same region are the sources of Poplar and Temperance rivers which flow southward, and of the streams which flow northward to Ogishki-Muncie and Knife lakes.

This river was explored as far eastward as the eastern shores of Wilder lake. The upper part of the basin of the river lies in the gabbro area, so far as examined, and probably this rock extends as far as its highest source. Yet in the next town east of that, in which lake Polly is situated, a red underlying syenite appears unconformably below the gabbro.* The description of the geology will be given in the order of examination, viz., from sec. 26, 63-10, where the river forks, eastward through the south channel to Wilder lake, and returning through the north channel in 63-9, and westward to Farm lake.

Syenite forms the shores from the fork of the river eastward to the S. W. ¼ of sec. 19, 63-9, where the river covers again the line of contact about a mile and a half.

In the bay covering most of the S. E. ¼ of the N. W. ¼ of sec. 19, 63-9, is a little island which must lie nearly on the contact line between the gabbro and the syenite. This consists of a firm, tough, contortedly gneissic rock of a dark color (purplish on fresh fracture) which is aphanitic, quartzless, and weathers red in some places. It has many veins, i. e. such seams as have been described above in the mica-schist in the northwestern part of Vermilion lake, each seam, on being weathered, being harder than the adjacent rock, causing a sharp ridge on the surface, such ridges crossing and reticulating with each other and varying in hight from a mere film that can hardly be traced, to half an inch or more. This rock seems to have been once in the form of a breccia, but not greatly displaced in its parts — perhaps only plastic. Some open spots have lost weathered-out fragments that were softer. In other places this rock looks as

* Tenth annual report, pp. 99-101.

if an igneous rock, now fine and diabasic, and hardly distinguishable from the rest, had been interfused with the broken fragments. There is a general, gneissic, coarse, perpendicular structure that runs east and west. This island rises but four feet above the water, and is only about twenty-five feet in diameter.

The same rock appears on the mainland, just north of the island, and also west of it, and rises twenty feet above the lake. It is a rock which seems to vary from diabase to felsyte, and contains cherty spots. The gneissic structure is not common. (980).

Lying to the southeast from the foregoing island are a couple of other small islands, situated near the contact with gabbro. These consist of a very hard quartzose biotitic gneiss, the structure running east and west, standing about vertical (981).

Proceeding northward from the river, into sec. 18, 63-9, about half a mile, through the forest, the surface ascends about 100 feet, and the rock is a fine-grained diabase, similar to the rock at the shore (980) in nearly all places (987). There is no distinct structure or bedding of any kind, but in some places a sort of lenticular flowage structure, seen on a weathered surface, like that in some of the changed graywacke south of Fall lake, although the rock, as a whole, has more resemblance to true doleryte. (Compare 996 and 997.) It has a marked tendency to a coarseness of crystalline grain, giving it a gabbro-like character and color (988). Such coarse gabbroloid rock forms the summit of one of the subordinate ridges between the main ridge and the shore, and seems to be a part of the main rock-structure. Two or three ridges, separated by sharp valleys, generally with perpendicular rock-walls facing north (sometimes also facing south), intervene between the river and the centre of sec. 18, 63-9.

At the rapids in the S. E. ¼ of sec. 17, 63-9, the gabbro, which appears here on both sides of the river, is very fine-grained and like a diabase, indicating that the rock 980 is only a condition of the gabbro. On the supposition that it is the contact condition of the gabbro, the gabbro must overlie unconformably the red rock (palisade rock), the quartzose gneiss, which has a distinct uniform and persistent bedded-gneissic structure E. and W. (981) as well as the gneissic syenite which sometimes is seen along here, near the gabbro boundary. This supposition apparently is confirmed by the existence of the igneous rocks Nos. 987 and 988 at so much higher levels, on the north side of the

river in sec. 18. This shows that there will be found outliers of gabbro rock, in the higher levels, at points somewhat further north than the boundary line expressing its general northern strike on the accompanying geological map. The following sketch-map (Fig. 46) of this part of the Kawishiwi valley will convey an idea of the position of these rocks.

Fig. 46.

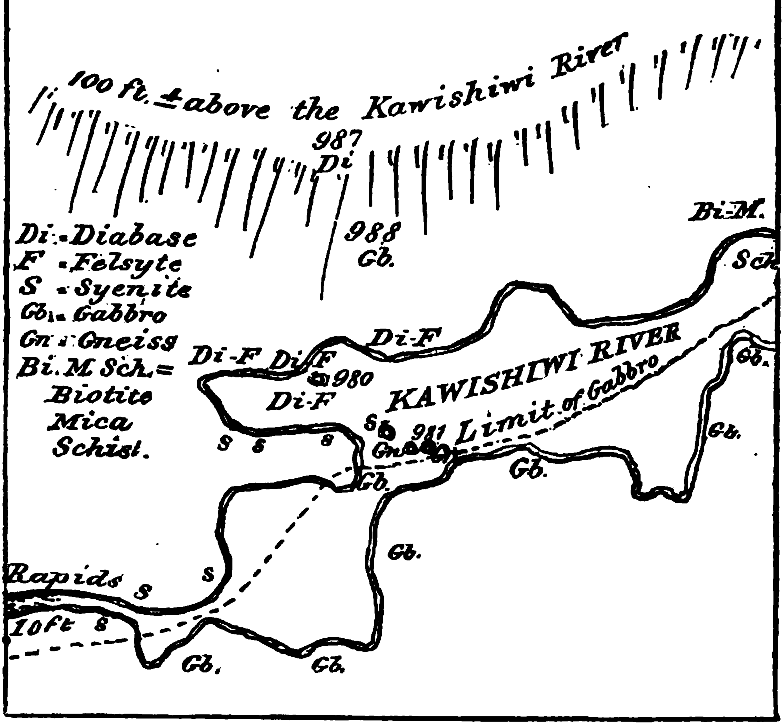


Fig. 46.—*Sketch-map of a part of the Kawishiwi valley, sec.* 19, 63-9.

The relative position of these parts is further shown by Fig. 47, which is a profile across the river from N. W. to S. E., passing through the islands.

A generalized perpendicular section, expressing all the facts observed respecting the gabbro contact, as they appear to be related by all the observations foregoing, may be constructed as shown in Fig. 48.

There are two grand groups of rocks here involved. One is

of direct or immediate eruptive origin, and embraces also the modified portions that are produced by coming into contact with the sedimentary beds. The other is of sedimentary origin and embraces the modified sedimentary masses. The former includes gabbro, fine gabbro, olivinitic gabbro and "muscavado," also the orthoclase-gabbro, or dioritic syenite and the diabase and dark felsyte. The latter embraces the fine syenite, the red, felsitic "palisade rock" of the Kawishiwi, gneiss, the quartzose and biotitic gneiss, and the porphyritic syenite. The last express the last term of extreme effect of the eruptive rocks on the sedimentaries, having resulted from complete fusion, and acting in all respects, among the other rocks, as an eruptive one. Many of the so-called dikes of this rock (or rock resembling this) are believed to be of chemical origin, and not connected with any source of molten rock.

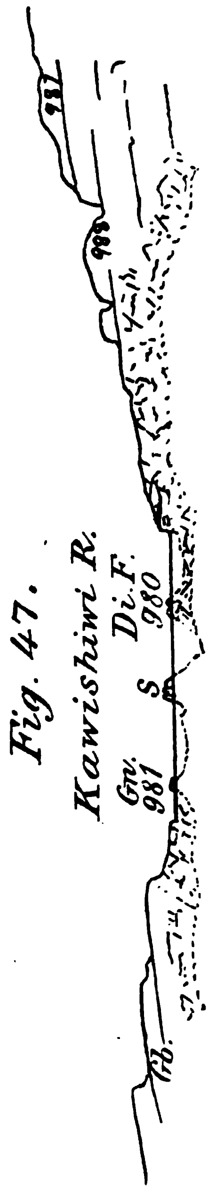


Fig. 47.—*Profile across the Kawishiwi, showing the gabbro-contact.*

In passing eastward, through town 63-9, the river divides in the S. E. ¼ of sec. 17, but unites again in sec. 27, embracing an island. This island is itself also divided into two parts by a subordinate forking of the river, making really three channels of flowing water occupied by the same stream —the north, central and south channels. Where the river first divides, the greater part of the water goes out by the channel that passes northward into sec. 27, and sec. 22.

The gabbro rock continues, by way of the south channel, to form the country rock, the elevations along the shore not exceeding thirty feet above the water, to the east side of the town, and also into T. 63-8. In passing through the last town, the land appears but little above the lake, the small undulations not exceeding ten feet, and the larger not more than twenty-five.

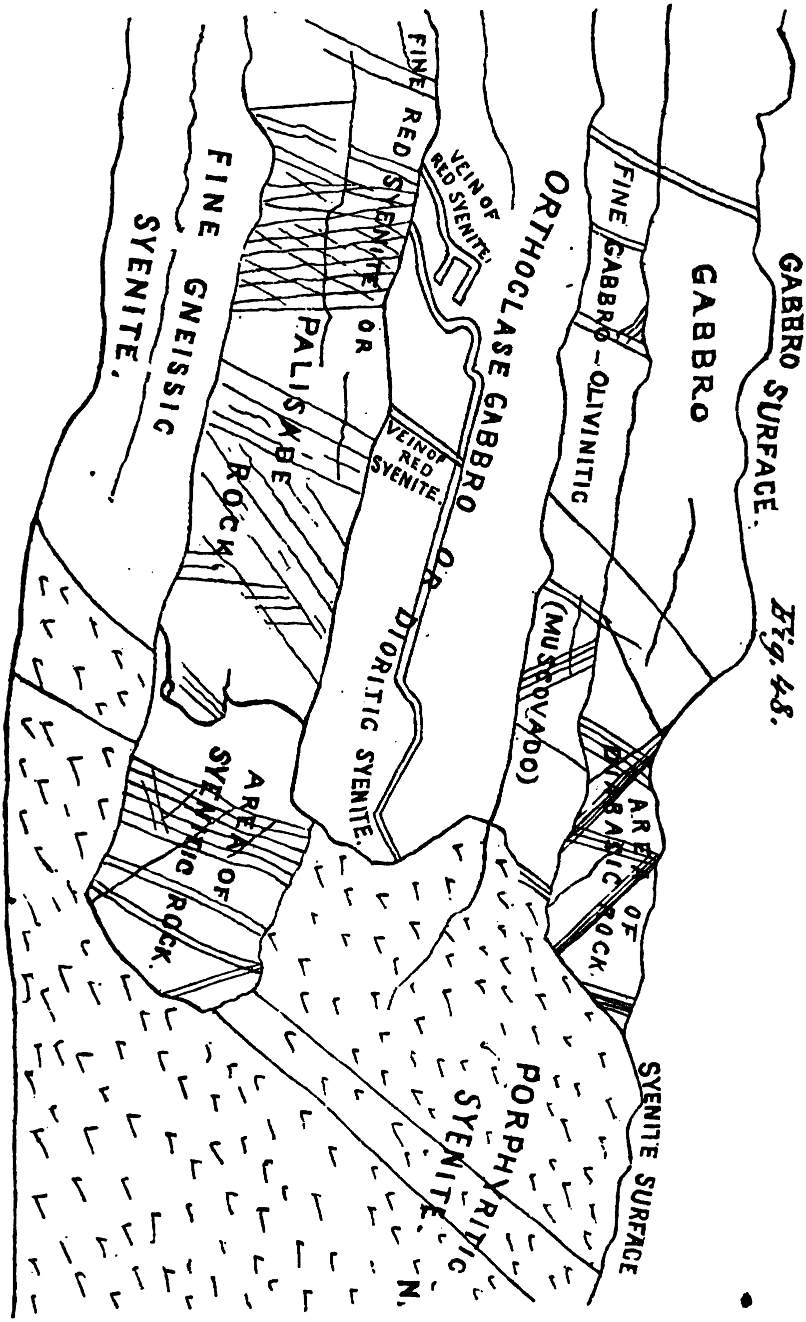


Fig. 48.— *Generalized section of the gabbro-contact on the sedimentaries.*

There is here no visible drift, or nearly none, except such as is referable to this rock. There are fine exhibitions of the process of making "*boulders by disintegration*," some bluffs being in process of decay but strangely retaining, undecayed, rounded boulder-like masses from two feet to six feet in diameter, the surrounding rock being so rotted that it can be picked to pieces by the fingers. There is no show of drift action — nor ice action, the rock everywhere being superficially crumbling off in flakes and in small bits so that in some of the bays the beaches consist of gabbro sand. There is not a total absence of transported drift, but only very rarely a boulder of granite. These also show the disintegrating action of age. The gabbro bluffs do not look clean and smooth-cut, but are falling down *in situ*, the joints being worn out so as to produce little channels in which water runs down to the lake. Old weathered surfaces are pitted with holes of all sizes, up to a hen's egg. On the tops of the hills is a thin, often gravelly, soil produced by the decay of the gabbro rock. The sand of the beaches in small bays where it gathers is made up of labradorite crystals, more or less rotted. The whole of Wilder lake has these driftless characters. They seem to show that at the last glacial epoch this region was not subjected to moving ice. This kind of surface extends from the west side of the lake in sec. 33, 63-8, eastward at least as far as the east end of Wilder lake, beyond which this trip did not extend. Throughout this area, although the rocks are bare much of the way along the shores, not a glacial scratch nor a glaciated surface could be seen, although on our return special notice was given to this feature. At the west end of the lake in sec. 33, 63-8, was seen one moutonéd surface, but it had no scratches. Gradually in passing still further west the rocks assumed a more preserved condition, and occasionally a rounded surface appears, and at the entrance of the main river, southern part of sec. 30, 63-8, is a striated rock-surface, the lines running S. 8° E. Further still west, such surfaces are more and more common, and finally every surface, facing toward the north, is found to be striated, and all the rock is hard and fresh. This interesting series of change can not be ascribed to any differences in the nature of the rock, because it is the uniform gabbro formation all the way, but must be referred to difference of glacial action. I think I saw also more frequent signs of transported drift about at the point where striated surfaces began to appear, though the drift in this part of the state everywhere is scant.

The more eastward direction of the marks noted above in sec. 30 is also significant. There was a little local disturbance of my needle at the point where the striation was noted, but an allowance was made for this by comparison with the direction of the needle at points near at which no disturbance was noticed. The normal direction of ice-flow in this part of the state, as noted further west, is S. 12° to 25° W. Hence the east margin of the ice-flow, which, according to Chamberlin, would have an outward movement from the axis toward the edge of the glacier, must have been that which produced these divergent scratches, leaving the country further east still uncovered.

About the north ends of the N. E.–S. W. lakes in secs. 15 and 16, 63-9, is an interesting series of exposures repeating the phenomena seen in sec. 19, 63-9, and showing pretty well that the rock there designated Di-F, or *diabase to felsyte*, is only a condition of the gabbro, and that the contorted gneissic structure which is rarely seen in it is superinduced by some local circumstances. Here the same rock, while showing frequently a coarse, often twisted and broken gneissic structure, also has a heavy bedded structure dipping in the same direction as the gabbro and conformable with it. The gneissic structure seen here runs N. 30° W. and is nearly vertical.

This rock not only varies to a gabbro, but also to an olivine-biotite-gabbro, or biotitic schist of fine grain, though the mica is not so arranged in it as to constitute the gneissic structure of mica-schist, but is rather uniformly distributed throughout the rock. There is in it also no quartz, that which might be taken for quartz at first, being rusted and rotted toward the weathered surface and crushing easily. No. 982 represents a series of specimens procured at various places showing different conditions of this biotite-olivine-gabbro, or biotitic schist, all from the N. E. ends of the little N. E.–S. W. lakes mentioned in secs. 15 and 16, 63-9, mostly in the rusted, semi-decayed and "muscovado"* state. No. 983 is an undecayed sample of the same. This has the clear gabbro-gray color, but is fine-grained. It consists very largely of the prevalent feldspar, but has much scattered black-mica. No. 984 is a quartzose biotite-gneiss from the same locality. As near as can be judged, from all the appearances, the downward transitions are as follows, though there

* This field-term was subsequently brought into use, and continued as a designation of this form of the great gabbro formation. There is certainly a no more exact comparison that could be made of the visible outward characters of this rock than to liken it to the "brown sugar" of commerce.

is no regular succession in vertical order, the variations being horizontal as well as perpendicular:

1. Gabbro, coarse-grained.
2. Biotite-olivine-gabbro, sometimes contortedly gneissic.
3. Diabasic and felsitic, dark-colored, rarely becoming gneissic and involving similar fragments that are fine-grained and welded with itself.
4. Quartzose biotite gneiss, unconformable.

The rock 983 continues southwestwardly through sec. 16, 63-9, and in the S. W. ¼ of the section it rises in bluffs from ten to thirty-five feet high on the south side of the north channel, constituting a large member of the gabbro rock. It is again represented by 985, but here appears to hold also olivine.

A similar fine-grained olivine rock or olivine-gabbro, extends along the north shore of the river in sec. 17 and 20, 63-9, but in the northwest part of sec. 20 the rock 986 appears near the water, which is a very fine-grained, gray micaceous quartzyte, or gneiss, belonging to the foregoing No. 4.

Near the centre of sec. 26, 63-10, on the south side of the lake, the outcropping syenite is very hornblendic, making a nearly black rock. In patches, however, is seen a fine red syenite, the transition from one to the other being abrupt. The red syenite becomes at once the prevailing rock. This fine red syenite is much developed, in hills about 50 feet high, in N. W. ¼ of N. W. ¼ of sec. 26, 63-10.

On the N. W. ¼ of sec. 27, 63-10, is a rock that is represented by 989 (four samples), a fine-grained, firm, slightly micaceous, quartzose (and also feldspathic) gray rock, with evident bedding (i. e. sedimentary) planes dipping east, 50° south, at an angle of 75° from the horizon. It resembles, at a glance, the graywacke of Vermilion lake, in color and grain, and almost every respect. The few mica scales seen are not of biotite, but are greenish. It is nothing different from some of the beds associated with the graywacke of Vermilion lake. It resembles 984, except that it shows no black mica. Across the river, N. N. E. from this rock is a nearly white gneissic rock, a kind of feldspathic graywacke, dipping N. E. his has some reddish-weathered spots. In the line of strike east from No. 989 is a small island in the lake, so near the shore that it can not be of any other rock than 989. It contains rock 991, and, while it is gray within, and has the same gneissic or faintly bedded structure, it weathers light-red and at a distance might be taken for fine red syenite.

A little east of 990 appears 992, a kind of chloritic syenite.

This is massive, or heavily bedded, without gneissic structure, weathers red—apparently an eruptive rock, at least being outwardly disposed like an eruptive. It is closely cross-jointed, making small, lenticular, angular blocks. It continues east along the north shore (993), as far as the quarter-post of sec. 22, and becomes the red syenite noted further east. On the point between the two bays, on the south side, N. E. ¼ of sec. 27, 63-10, the rock is the same as 991, and dips southerly, but with a less evident gneissic structure. Finely twisted and back-folded bedding can be seen on the weathered surface, like some seen in the graywacke on sec. 20, 62-15, showing a former plastic, or nearly plastic, condition. In the midst of it appears rock represented by 994, which is a fine red syenite. This is taken at random from the surface of this graywacken gneiss. It is sub-crystalline, yet contains many fragmental grains. The color is light-red, sprinkled through, or about evenly divided with, a light-green, the former being apparently orthoclastic and the latter chloritic. This shows the possibility, nay, the actuality, of this graywacken gneiss becoming the prevailing red syenite of this region, the whole having resulted, as already intimated, from a modification of the sedimentaries. This graywacken gneiss, when fused completely, seems to have produced the rock 993. When changed less it constitutes the "palisade rock" of this region, and mingles with the gabbro. When less changed it makes the red-weathering fine sub-crystalline gneiss. This interesting observation, while it may not account for all the red syenite, and the gneiss of the region, yet affords a plausible supposition for the origin of that which is closely associated with the gabbro rock. It seems that no theoretical conclusions based on mineralogical paragenesis and on microscopical inspection of thin sections can be brought to bear adversely on so conclusive field evidence as is here afforded within the space of a quarter of a mile.

Another form of the modified sedimentary rock is 995, which succeeds to the rock 991 in the N. W. ¼ of sec. 28, 63-10. It is hornblendic, quartzose, orthoclastic—at least has reddish feldspar grains (not crystals)—micaceous, gray, firm. It makes the long rapids here, and rises in the form of a ridge running N. E. and S. W. in the direction of the strike of the rock 991, rising about 80 feet above the river. The dip is southeasterly, at an angle of 80° from the horizon. Along the immediate river channel this rock rises on the right and left somewhat in the

manner of the red syenite or "palisade rock," nearly perpendicular, having a jointed and pseudo-basaltic appearance.

At the foot of the portage-trail which passes, on the north side, round these long rapids, N. W. ¼ sec. 28, 63-10, but a little to the north, is a hill-range made up of a different rock (996). This is similar to that which makes the Kawasachong falls, and also resembles the rock 987.* This is a heavy, basic rock, of eruptive origin, much confused, containing some quartz veins conformable with the flowage structure, and some red-weathering crystals or patches. From this place the ranges seem to bear away somewhat N. of W. since, at the beginning of the next rapids, on the north side of the river, a syenite, like 993, appears as a "palisade" bluff. This is in the north part of sec. 29, 63-10, near the north section-line. Syenite rock forms the rapids also in the N. E. ¼ of sec. 30, and continues to the town-line between 63-10 and 63-11, sometimes varying to a gneiss, which again varies to mica-schist. This mica-schist can be seen on the south side of the river in the S. E. ¼ of sec. 30, and a quarter of a mile further west on the north side. At the town-line the bluff on the south side is about 30 feet high and consists of syenite.

For a description of the remainder of the Kawishiwi valley, from the town-line to Farm lake, in 63-11, consult the report of A. Winchell.

GENERAL THEORETICAL SECTION OF THE FOREGOING DESCRIBED ROCKS.

A provisional attempt may now be made to group the descriptions that have been given of the chief hill-making rocks in some systematic stratigraphic scheme. It seems to the writer that the rocks are related stratigraphically to each other as expressed by the figure (49) that follows.

Fig. 49.

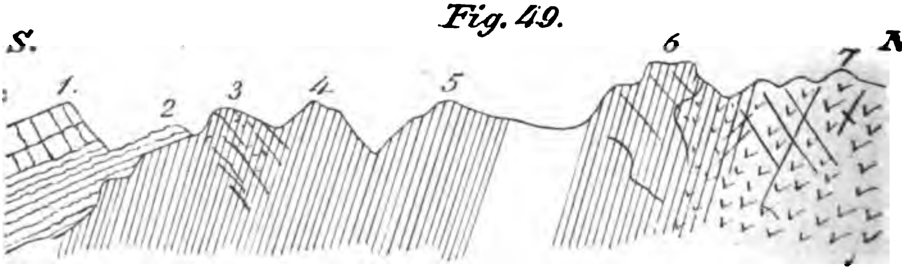


Fig. 49.—*General geological section.*

EXPLANATION OF FIG. 49.

1. Gabbro; this seems to have been poured out and spread over the upturned sedimentary beds that preceded it. In its lower portions, where it came into contact with the sedimentaries, it was variously modified into No. 2, and also embraced and transported masses that were detached from the sedimentaries. It probably issued from innumerable vents, but the points of issue were probably arranged somewhat as the rock is distributed, i. e. in a longitudinal series running from Duluth to the boundary line at Gunflint lake. This is a true eruptive rock and came from a deep source within the crust of the earth. It forms the great Mesabi range, and is iron-bearing, the iron generally being titanic.

2. Diabasic doleryte. This also takes the forms of olivine-bearing and biotitic gabbro ("muscovado"), especially when the gabbro boundary is adjacent. When the gabbro boundary is more remote, this rock alone seems to make important hill-ranges, and is then not so apt to be biotitic. In some places this is a conspicuous rock, and in others it is of not much account in a topographic sense. It causes the falls of Kawasachong, extends along the south shore of Fall lake in both directions, east as far as the Pipestone rapids, hardens the graywackes south of Long lake, lies on the jaspilyte at various places, and by incipient decay is converted to a more or less fissile chloritic schist, and in this state seems to pass sometimes for a sericitic schist. This is a true igneous rock.

3. Reddish gneiss and syenite, both coarse and fine grained. The "redrock" of earlier reports, particularly that associated with the gabbro along the Mesabi range. The Misquah hills are composed of this. The syenite of White Iron lake, and that of the Giant's range ("Messaba Heights") are supposed for the present, to be extreme exhibitions of the outburst of this rock. It seems to be due in this last case to a fusion of the sedimentary beds *in situ*, and the protrusion of the molten rock through the openings that may have existed in the adjoining strata. Still in most cases there was no complete fusion, but a more or less advanced recrystallization of the sedimentary strata *in situ*, as in sec. 27, 63-10. This has been regarded as of Laurentian age.

4. Broken and hardened graywacke, sericitic schist, argillyte, quartzyte and jaspilyte. This member is protean in its composition and variations. It seems to include most of the rocks about Vermilion lake, except the schists of the Vermilion group, and such of the schists or other modified rock as may prove to be of eruptive origin in the southern part of the lake. The argillitic slates are simply a variation from the sericitic schists. The jaspilyte and ore are sometimes a magnetic quartz-schist, and sometimes nearly black. This seems to graduate conformably into the next.

5. Mica-schist, hornblende schist and diroyte. *The Vermilion group*. This graduates conformably into a gneiss 'and to a granite, which has been regarded as of Laurentian age. On the other hand where No. 3 graduates into the bedded sedimentaries, it is apparently always syenite, and has been regarded Laurentian.

6. Mica-schist and granite veined with syenite and granulyte. This is the lower portion simply of No. 5.

7. Lower syenite and gneiss, generally regarded Laurentian.

There are a great many unsettled problems yet involved in the

geology of these rocks, the solution of which can not now be given. When they are investigated—and some of them must be before the above scheme can be considered demonstrated—they may show that it is necessary to vary from this generalization. There are some reasons for believing the Animikie rocks overlie the greenstone (No. 2 above) and underlie the gabbro. It is only designed here to express, so far as the work of the survey has progressed, what grand results of stratigraphy and rock-genesis are indicated.

FROM FALL LAKE TO THOMAS LAKE.

Felsitic schist, probably a rotted condition of the felsyte (or porodyte) that forms Stuntz island, is the rock causing the rapids at the N. E. end of Fall lake, sec. 3, 63-11, but in some places further down, a glittering micaceous schist appears. On the portage trail this schist is seen to be sometimes fine and almost flinty. (1109.)

Basswood lake. At the beginning of Basswood lake (pipestone rapids) the rock consists essentially of the green rock (or a green rock) which has been supposed above to be of igneous origin, and a syenitic gneiss. There is a perpendicular contact of the two visible in the bluff on the right side of the river about six rods below the foot of the "falls." The green rock, however, rarely shows its original condition—a perfectly preserved doleryte, but varies to a hornblendic rock, and to a fine mica-schist. Tremolitic schist seems also to be one of its conditions. The greatest change of this kind is seen near the top of the bluff, and along the open seams and at the point of contact with the syenite. The cliff on the left bank I did not examine, but it had the general jointed aspect of a basaltic rock, and seemed to be either wholly eruptive or so affected by igneous contact that it has acquired an igneous facies.

The syenite is closely jointed, nearly perpendicularly, so as to present a basaltic structure, simulating sedimentary bedding. It is rather fine to medium grained.

In section 6, 64-10, at the west end of the portage the rock is mica-schist and syenite, but mostly the former, having conformable and approximately conformable bands and veins of syenite, as represented by 1108. It is a firm rock, having a bedding, or at least a fibrous lamination that runs south, 60° west. But this structure is often interrupted by nodules of syenite, and is con-

torted and curving, and seamed, holding some veins of chemical quartz that extend in the same direction. This mica-schist is part of a prominent belt that strikes S. W. from sec. 6, 64-10, across the bay, forming islands and hills, into secs. 1, 11 and 15, 64-11. The rock is firm, having a firm, leaning, columnar, pseudo-basaltic jointage, which is cut perpendicularly by another set of planes that from certain points of view cause a semblance of sedimentary bedding to appear dipping N. W. about 40°, and the upright basaltic and schistose structure dipping S. E. about 75°.

The island crossed by the section line between secs. 11 and 12, 64-11 (the northerly one), is made of what appears to be a fine-grained, dark, firm, fibrous, siliceous, actinolitic schist (No. 1026). It rises fifty feet above the lake. The rock has a distinct strike, about N. 45° E., and dips S. E. about 75° from the horizon. This shows no banding like sedimentation, but a finely streaked and schistose upper surface. In these streaks are involved different minerals, the principal one apparently quartz. Sometimes the streaks are arranged on the weathered surface like

Fig. 50.

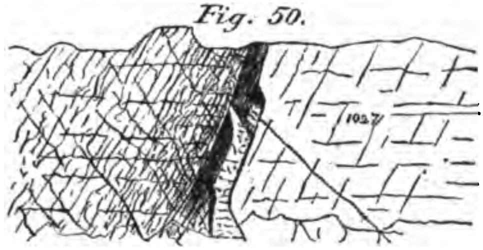


Fig. 50.—*Apparent igneous rock changed to mica-schist.*

that which is attributable to igneous flowage, seen on diabase rocks. Throughout it, runs the finely fibro-schistose structure or rift, which causes it to disintegrate in sheets, and irregular blocks and flakes elongated in the direction of the strike; cut, however, transversely by jointage into somewhat sharply angular forms. It has very much the aspect, at a distance, of a sedimentary schist. Still it can all be supposed to be a modified eruptive rock. If so it is not allied to the green chlorite schist which at Garden lake results from a change of diabase, but is probably of older date, and belongs in the Vermilion group.

On an island in the lake, in sec. 1, 64-11, another distinct contact can be seen in this old group. It is represented by Fig. 49. It runs nearly perpendicular from the water.

In the contact plane is developed a quartz vein about a foot wide. The rocks here concerned are as follows:

1027. Gneissic syenite quartzose, reddish, medium-grained, apparently becoming micaceous by change, on the right of the contact.

1028. Micaceous dark rock, from the left of the contact, but near the quartz. This contains a thin, reddish, granulyte vein. This is dark-colored, and though micaceous is not a mica-schist. The other minerals are difficult to determine, but there are evident quartz and red feldspar.

1029. About one foot from the contact, evidently cemented by a quartz frame-work, but contains mica and reddish orthoclase.

1030. Dark, reddish-gray, siliceous, fine-grained, massive, but rather coarsely jointed.

1031. Similar to 1028, fifteen feet from the contact.

These two rocks, by their color, jointage and general facies, show a noticeable contrast. The evidence is not conclusive that the dark rock was originally igneous,—nor that the light-colored one was originally sedimentary, but the gist of the whole, in the light of other observations, rather indicates it. There is, however, more evidence that the dark one is sedimentary than that the light one is eruptive.

The rock of Northeast cape, sec. 23, 65-10, is represented by No. 1032 — a fine-grained gneiss which is micaceous rather than hornblendic. It weathers red, though it is gray within, sometimes showing the warped and lenticular inclosure of masses of apparently some other rock round which a schistose flowage structure is developed.

This rock (1032) is cut by two bands of dark gneissic rock, represented by 1033. This appears to be a micaceous, quartzose dark gneiss similar to No. 1030. These bands run about E. and W.

It is also cut and ramified by rock 1034, a sort of coarse vein-rock, or reddish granulyte, apparently containing the same minerals as 1032 (except mica), but in larger crystals. This is probably of chemical origin. Rock 1033 is also cut by veins of light-colored granulyte, but less coarse.

On the portage from Ensign to Illusion lakes. Argillitic slate appears near Ensign lake, N. E. ¼ sec. 14, 64-8, fallen in detached masses so as to lie in discordant strike in various positions. About half a mile further a ridge of modified graywacke and of

schistose slaty argillyte, rises about sixty feet on the north side of the little creek, and the portage trail passes over it. Its strike is N. 65° E. At the east end of this portage, near the centre of sec. 13, 64-8, rock No. 1035 is exposed at several points. It is a fine-grained, dark-gray, heavy rock (olivinitic?), which appears in some places schistose (E. and W. and vertical) though not with that fine schistose lamination seen in the chlorite schists; but much more coarsely and brokenly-irregular-flowage lamination, the parts being connected by vein-matter which shows a rigid reticulation on the surface when weathered. It seems in the main to be a sedimentary rock, though apparently invaded and sometimes permeated by igneous matter. Very rarely can a distinct sedimentary banding be seen, though this veining and this schistose structure, being in the usual direction of the strike of the schists and sedimentary beds, would very easily pass for sedimentary structure.

Illusion lake. The north shore of Illusion lake has several outcrops of the same rock (1036) as the last described, with occasional better evidence of sedimentary structure. The strata (?) stand about vertical, or dip toward the south 80°–85°. As a sedimentary rock, it would be designated in the field a fine, gray, arenaceous quartzyte. But it is heavy, and considerably resembles some form of the gabbro rock near its contact with the sedimentaries. It is greatly broken and recemented. On a little island near the southwest shore, this rock, or a similar one, is contorted; and although bedded, and like sedimentary rock in its apparent structure, it is twisted like some of the graywacke seen at Tower, dipping in opposite directions on the same surface at intervals of twenty feet. The main strike seems to be northeasterly, but the convoluted condition of the strata, imitating that of some of the jaspilyte, will not justify any statement that can be relied on as to strike.

The south half of this lake has shores of gabbro (1038). It first appears, on the east side of the lake in the form of 1037, a muscovado gabbro, finely granular, somewhat gray or yellowish.

The curiously involved and convoluted bedding seen in the rock on the small island above mentioned, and in other places about this little lake, as well as at other points where this horizon is encountered, seems to pertain to the under portion of the gabbro, the irregular contortions being due to flowage over the uneven surface of the older rocks.

From a small island, a little south of the island above de-

scribed, was obtained No. 1039, which is a biotitic gneiss, the same as seen at the most northern turn of the Kawishiwi, and at the same relative position respecting the great gabbro overflow.

At the portage from Illusion lake to Ima lake the trail passes over a ridge of gabbro that rises perhaps seventy-five feet above Illusion lake.

The shores of Ima lake are formed of gabbro entirely. The stream which enters the east end of Ima lake expands into a lake in sec. 20, 64-7, and also again in sec. 29 soon after it leaves Thomas lake.

Thomas lake. The entire shore of Thomas lake, and all its islands, consist of gabbro in some of its modifications.

On the N. E. ¼ of sec. 29, 64-7, a little west of the meander corner of secs. 28 and 29, the gabbro assumes a very ferruginous character, even constitutes a fair iron ore, but it exhibits only a small outcrop at the beach. The needle is disturbed by it. The chief other ingredient of the rock is olivine. In other places near here the gabbro is not noticeably ferriferous, but is olivinitic. This ore is No. 1040.

Near the central part of Thomas lake, in the N. W. ¼ of sec. 33, 64-7, are three isolated crags of gabbro standing out of the water, having fantastic forms. These were named Liberty cap, Sphinx and Pyramid islands.

Frazer lake is similar to Thomas lake, in its geology. It even has a similar magnetic iron ore deposit on its north shore, (S. W. ¼ sec. 14, 64-7) formed by a ferruginous spot in the surrounding gabbro. A good quality of ore can be obtained here (1041), but it might be badly affected by titanium. At the place of this iron deposit, a few years since, some mining was done *for gold!* The works were in the gabbro rock. The owner precipitately abandoned the place, refusing to carry away the assaying apparatus, and the chemicals, mining tools, provisions, dynamite, and also the "assayor" under whose guidance the work was carried on, involving an expense of several thousand dollars. The man who was abandoned was taken away subsequently by some Indians. A forest fire injured some of the property, but the shanties, the chemicals, hammers, drills and assay jars, cupels, forge, anvil, etc., still remain, a testimony of ill-guided cupidity, such as becomes infatuated with the belief that wherever some "experienced miner" declares coal, or iron, or gold exists, there it is safe to expend money in search for it.

About the shores of the lake in the river, in sec. 11, 64-7,

appears the intermediate, gneissic, biotitic gabbro (1042) which here seems to embrace pieces of other rock and has contorted bedding and flowage structure. It resembles in all these respects the phenomena seen on the islands in Illusion lake. Here it appears as the lower part of the gabbro. Indeed the most northern exposed rock seen on this lake is a true gabbro, but fine-grained and rusted, having the aspect of muscovado sugar.

The ridge which separates the lake in the river, from Kekekabic lake is formed apparently by a fine-grained greenish rock. The north declivity is over a hundred feet, but the south side descends not more than ten. This green rock is probably a somewhat rotted condition of the fine-grained lower part of the gabbro.

Kekekabic lake. At the southeast end of Kekekabic lake, at the head of the little gulf projecting into sec. 11, 64-7, the rock that appears at the shore is represented by No. 1044. This rock is speckled with light flesh-red crystals apparently of orthoclase. It is sub-crystalline throughout, but its grained-color is gray. It is another illustration of recrystallization of the sedimentaries in the vicinity of disturbance. This was apparently a graywacke rock at first.

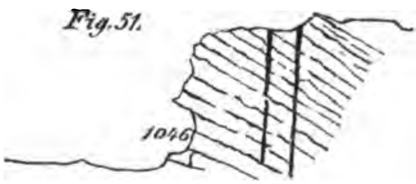


Fig. 51.—*Profile of the south side of an island in Kekekabic lake.*

The same rock extends along the south shore of Kekekabic lake through secs. 2 and 3, 64-7, but becomes more and more red and syenitic. (Nos. 1045 and 1046.) It also constitutes the islands in the lake that are situated in sec. 3, 64-7 (Nos. 1100, 1101). The aspect in general is that of a thin-bedded gneissic (syenitic) rock, the bedding dipping southerly about 25° from the horizon. On the island near the centre of sec. 3, 64-7, a bedded structure is brought out to view by weathering, and is not that of sedimentation, only so far as its direction may have been due to that cause. It is now rather the coarse undulating bedding that is often seen in igneous rocks, that have been in flow. This dips about 25° N. and is crossed by joints that give it a coarsely columnar aspect when viewed from certain directions. Fig. 51 shows the profile of the south side of this island.

The most westerly island is represented by rock No. 1100. This is a reddish syenite, but was a fragmental rock originally. It has a rather fine, lenticularly schistose jointage that is irregular in its direction and in its fineness. On the north side of this island this rock is less red, and grayish-green (1101) though still having some red orthoclase mingled with it somewhat porphyritically. This shows a nearer approach to the original grayish sedimentary condition. It is a firm rock, with free quartz, sub-crystalline, and apparently a mixed syenitic metamorphism after some graywacke. It is sparingly spotted with what appear to be forms of boulders and pebbles due to an original conglomeritic condition.* These are now greenish, or micaceous, contrasting markedly with the mass of the rock. There is visible sometimes not only a conglomeritic, but a sedimentary, banded structure, dipping 30° from the horizon, south 10° west. Yet the most conspicuous bedding is that which dips 30° to 40° N. 10° E. This (latter) causes on the south side sometimes a perpendicular or overhanging bluff, by the underwear of the lake. This somewhat undulating, north-dipping bedding is what I have called sometimes provisionally a flowage structure, and it may be due to that, since when it is most developed the sedimentary banding is invisible. The sedimentary banding is visible most distinctly at the southeast angle of this island. Here was sketched Fig. 52.

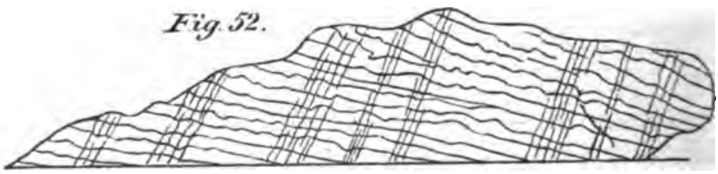


Fig. 52.—*Profile view of the westerly island in Kekekabic lake.*

The largest island—Animikie island—is represented by rocks 1102, 1103 and 1104, the first from the west end, the second from the northwest corner, and the third from the east end of the island. The first is the same quartzose syenitic rock as 1101. The second shows red and gray variations, due probably to difference of composition in the original, and the last is greenish, fine-grained, heavy and diabasic, probably the same as the original of No. 1043.

There is a little island northeast of Animikie island situated

* Compare the Sauk Rapids gray "granite."

in the N. W. ¼ of sec. 2, 64-7, which consists in the main of this same firm syenite. But it is porphyritic, at the same time that it is conglomeritic. This is shown by No. 1105, from the north side of the island. A little further toward the east was obtained No. 1106, which is a biotitic crystalline rock, gray in color but porphyritic with flesh-red feldspar, and blotched by pebbly forms. A single specimen shows all these characters. It is fresh and hard. This must have been very near the transition point from the biotitic gabbro to the older sedimentaries, and shows a mingling of the characters of both, the original clastic rock having been a conglomerate. The porphyritic crystals are developed both in the pebbles and in the matrix, but in the former are numerous reddish grains that are not perfect crystals, giving the areas of the pebbles a very distinct contrast with the gray matrix. The biotite scales or crystals are scattered, so far as seen, only through the general matrix. Some of the pebbles are of green chloritic rock.

It seems that the gabbro sheet must have extended considerably further north at first, covering the sedimentaries and changing them by its heat, and that by glacial and other atmospheric agencies, its northern limit has been driven south, uncovering the modified rock. Thus —

Fig. 53.

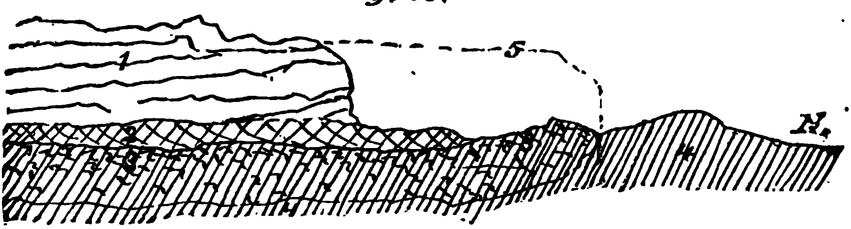


Fig. 53.— *Theoretical northern border of the gabbro and its relation to the sedimentaries.*

EXPLANATION OF FIG. 53.

1. Gabbro sheet.
2. Contact layer of the gabbro sheet, sometimes diabasic, and sometimes biotitic and fine-grained.
3. Modified upper surface of the sedimentaries.
4. Unmodified sedimentaries.
5. Supposed original limit of the gabbro sheet.

At the southwest corner of Kekekabic lake, S. W. ¼ of sec. 3,

64-7, the rock 1047 embraces 1048. The former is a fine-grained gabbro-like rock, not typical gabbro, but evidently that condition of the gabbro sheet which is always met near the northern limit, and the latter is in sub-angular and rounded pieces, and sometimes seems to shade into the inclosing rock, or at least to become so intimately united with it by cementation that no line of distinct transition can be seen. It appears finely granular — even as finely granular as the disintegrating jaspilyte of the iron-bearing rocks at Tower. Its color is gray, and were it not so finely granular it might be considered the same as the "muscovado" rock before mentioned — which indeed it may be in its nature and origin. Most of the inclosed pieces are rounded. The inclosing rock, 1047, weathers away much faster than these inclosed pieces, and hence the rough outward appearance caused by the projecting knobs of 1048 gives the weathered surfaces a jagged and forbidding aspect, — particularly when approachd in a gale, in a birchen canoe.

At the same time this coarse, apparently fragmental rock, is replaced, at intervals, by a rock that is seamed in all directions like the diabasic schist, or biotitic gneiss, seen in so many places, the seams being firmer and persistent, while the mass of the rock wears away, producing a reticulated network of prominent and finer sharp ridges all over the exterior.*

An eighth of a mile northwest of where Nos. 1047 and 1048 were obtained (where no distinct prevalent dip could be seen, but apparently a grand structure dipping S. W.) is an appearance of the same red rock as 1046, dipping W. N. W. It forms a bluff about ten feet high, but does not continue far, for the lower part of the igneous formation returns, exhibiting the same characters, in a bluff that continues along the west shore of the bay in the east side of sec. 4, and rises 25 or 30 feet perpendicularly. In this bluff only the lower part appears to be pebbly (1049); while the top appears to consist of a fine-grained gabbro (1050), some of it having disseminated red crystals, making an orthoclase-gabbro (1051).

When this orthoclase-gabbro comes into contact with the red-rock (1052) it acquires the orthoclase element. One such contact is seen a little further north — at the W. ½ of sec. 3, 64-7 — on the point, and the red-rock dips S. S. W.

Along the east half of the south side of the little bay at the N.

* A photograph was made of one of the larger fallen weathered fragments as it lay in the water near the bluff.

E. corner of sec. 4, 64-7, a fine-grained nearly black rock (1053) strikes nearly E. and W. and along the west half it strikes N. E. and S. W. and at the depth of the bay the overlying pebbly igneous rock appears on a sharp little point. This rock is evidently one of the fine-grained of the fragmental series. It has a bedding that dips conspicuously at an angle of 45°-50° east, then E. 30° N., then N. W., then N. then easterly again. This seems to have been some argillitic portion of the graywacke series. As metamorphosed and broken, it appears as a petrosiliceous black rock, showing grains of quartz. No. 1054 shows the nature of the weathered surface, on which is a finely reticulated network of projecting siliceous sheets that seem to rise from the interior of the mass, but may be only siliceous matter that had accumulated in the open joints prior to the commencement of the weathering process. This is sometimes a slaty rock, and sometimes a black slate, but generally a distinctly bedded, nearly black, brittle siliceous rock. It resembles the Animikie slates which run along the international boundary eastward from Gunflint lake.

The pebbly gabbro, which becomes chloritic by decay (Nos. 1049 and 1050), extends along the west and northwest side of the bay that projects north in sec. 34, 65-7, and becomes a lenticularly and coarsely schistose greenish schist (1055), the edges standing vertical, illustrating a transition to schist exactly like that which has been described on the west side of Garden lake. This schist holds rounded pebbles. It also has in its seams a pinkish orthoclase associated with quartz (1056). It is cut by a greenstone dike running nearly E. and W. near the shore, in sec 34, which is about eight feet wide. Along the shore in the N. W. ¼ of the S. E. ¼ of sec. 34, 65-7, the same siliceous rock as Nos. 1053 and 1054, again appears, with a distinct, and almost continuous, dip nearly south, about 80° from the horizon. East further in the same section, and in sec. 35, the chloritic rock becomes a conglomerate. It is crowded with rounded, or subangular, foreign pieces. It is sometimes schistose, sometimes gneissic, sometimes massive and nearly always pebbly. No. 1057 represents this rock when not pebbly nor schistose, from near the meander corner between secs. 35 and 36, 65-7, on the north shore.

This chloritic-schist-conglomerate is, in some places, rather more micaceous than chloritic, and sometimes it approaches the graywacke in appearance, showing a sedimentary banding. At

the portage that runs north to a little lake (Pickle lake), near the east side of sec. 34, all these features can be seen by making a little examination right and left from the trail. At the north end of this portage the rock is graywacke and slate at the landing, but south from there, the strip of land over which the trail goes contains a rather chloritic sometimes conglomeritic rock. The sedimentary banding when visible runs in somewhat variable directions, but seems to be in general east and west; and the prevailing dip is south when the beds do not stand vertical. There is a coarse-schistose, vertical structure produced in these beds nearly everywhere due to disintegration, and quite often a heavy pseudo-bedded structure that dips easterly or southeasterly about 45°. This last is more properly a jointage, and appears where the heat and metamorphic action of the gabbro overflow, which may be considered once to have extended as far north as to cover this, had its influence on the old bedded rocks. This is visible near the point west of the portage landing on the shore of Kekekabic lake (sec. 34) and dips ten degrees east of north. At the same time at the water's edge, and elsewhere, the usual sedimentary banding demonstrates the true dip to be S. 40° E. about 78 degrees, and the slaty-quartzyte stratification is brought out plainly by the action of the weather and water.

The hill near the shore, N. W. ¼ sec. 36, 65-6, is represented by the rock 1058. This hill, in the main, consists of a pebbly and conglomeritic rock, the forms of the pebbles appearing on the weathered surfaces, but there are also large areas on the weathered surfaces where it does not show any contained pebbles. The rock is green, massive, firm, medium-grained. The conglomeritic patches exhibit, sometimes, on the weathered surface, a banding that appears to be due to sedimentation. In the interior, when freshly broken the conglomerate does not exhibit its composition. On weathering, a lighter color is given to some of the stones. The whole mass is coarsely jointed, non-schistose. But the same rock, along the shore in favorable positions, becomes schistose. It seems as if the great Ogishke conglomerate in some way is involved with and gives character to, the diabasic rock which is here represented. Probably its pebbles, freed from their matrix, are again embraced in this, and perhaps large masses of itself were detached, involved in the eruptive mass, worked over by fusion, and now produce the variations we see. In other cases the banded structure of the original is preserved, and is evident when exposed to the elements.

At the N. E. ¼ of sec. 36, 65-7, on the north shore, is a different phase of this green rock, rising almost perpendicularly from the water nearly 100 feet. This is not schistose, but jointed, and falls in blocks (1059). It is a firm, green, fine-grained rock, spotted with light-green, and sparkling with porphyritic crystals of apparently hornblende. Compare rock 751.

At the narrows of Kekekabic lake, which is at the town line between 65-5 and 6, is the porphyry rock 1061, and the relation it bears to the foregoing chlorite-schist-conglomerate is shown near the water line, where the following diagram was sketched. It rises through the green rock, leaving a small amount of the latter on the south side, between it and the water.

Fig. 54.

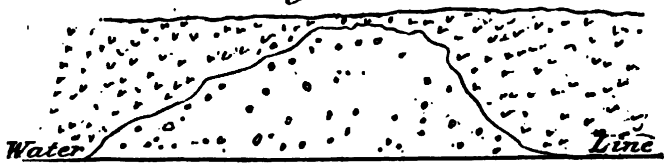


Fig. 54.—*Relation of the porphyry No.* 1061 *and the chlorite-schist-conglomerate. The porphyry rises up through the chlorite-schist-conglomerate.*

In the chlorite-schist (1098) here sketched the structure runs E. and W. and has an abrupt contact with the porphyry No. 1061. The porphyry is not only porphyritic but conglomeritic. The feldspar crystals are nearly white. It contains plainly a considerable amount of free quartz (1061 B.) In it are also crystals of biotite. The ground-mass is granular, gray and sub-crystalline. The feldspar crystals compose about one-third of the entire mass. The rock shows nowhere a sedimentary banding. Some of the pebbles are from six to ten inches in diameter, and water-rounded. These are all (now) of the form of some greenstone (1061 A), and present a contrast with the nearly white-weathered surface of the rest of the rock. This rock forms an isolated rounded knob near the lake shore, rising about 40 feet, and extending back about 15 rods, where, after a valley is passed, rises a high ridge of hardened graywacke weathering green and appearing almost like a true greenstone, though showing sedimentary banding. This second ridge rises about 150 feet, and appears at the lake shore on either side of

the porphyry, the latter rock being the cause of the northern shore swelling a little southward, causing the narrows of the lake. This green ridge is in the continuation of the rock 1058, 1059 and 1097, all being hardened (or later rotted and fissile) phases of the graywacke-slate-conglomerate formation, but sometimes so involved with the lower part of the gabbro overflow that they can hardly be distinguished from the diabasic condition which that assumes near the contact. The porphyry (1016), which acts the part of an igneous rock, is evidently a condition of the slate-conglomerate after fusion, and comes up like an eruptive rock through the green, hardened graywacke Nos. 1060 and 1098.

The green ridge mentioned continues northeastwardly, and culminates in Mallmann's peak which rises about 230 feet above the lake in the S. E. corner of sec. 30, 65-6 (1095). It would seem that the bed of Kekekabic lake is excavated in the green conglomeritic rock resulting from the contact of the gabbro overflow on the graywacke conglomerates.

The point which has the section corners of secs. 29, 30, 31 and 32, 65-6, north shore of Kekekabic lake, is made of porphyritic rock similar to that last described at the narrows, represented by No. 1094. It is wholly worked over from a conglomerate, some trace of the pebbles being yet visible, in changes of color, and in aggregations of different crystalline minerals in nodules, seen in spots on a fresh surface. It is one of the steps in the metamorphism of the conglomerate of Ogishke Muncie lake, but little less profound than that seen at the narrows. This is in the direct line of extension from that. This is a grayish rock (resembling 1078), and the crystals that are most conspicuous are those of a nearly white, but sometimes reddish, feldspar, apparently orthoclase, and of a greenish mineral that looks like hornblende, but the whole matrix seems to be as nearly crystalline as the situation would allow. It is rather tough, but not so tough as a doleryte. Very small quantity of free quartz can be seen.

West of this point a dike of doleryte runs from Mallmann's peak, and appears in the lake in the form of a couple of small islands. These islands are nearly on the section line between 30 and 31. The dike, which is 18 feet wide, has a marked contact phenomenon on each side, and a selvage streak separating it from the slate, etc., through which it runs. Its direction is 10° W. of S.

The rock No. 1062 is a recurrence of the porphyry Nos. 1094

and 1061. But this is further east,— S. E. ¼ N. E. ¼ of sec. 28, 65-6, near the narrows of Zeta lake. It lies to the east of a greenstone dike which runs along the water's edge, cutting the slates. It rises in hills on each side of the narrows from fifty to seventy-five feet. It falls down in angular basaltic blocks along the beach, and has a firm resistance to the weather. It is plainly, at first, porphyritic, but on closer examination it is not only seen to be also conglomeritic, but the porphyritic spots appertain largely to the inclosed pebbles. In other places the crystals are disseminated through the matrix, which is a dark, or dark-greenish rock like a diabase. This does not show any schistose structure here, but it shows occasionally the linear distribution of parts which is so like sedimentary banding that one would refer it to the action of water in distributing the materials, were it not so plain that the rock has taken its position and condition through the action of eruptive forces. The crystals of feldspar are apparently orthoclase, but there is in the rock a large constituent of hornblende, or changed hornblende. There is in it occasionally a pebble, but each such pebble has undergone a recrystallization, and has been so blended by partial fusion, with the matrix that in many cases the outline is not distinctly defined; but the existence and size of the pebble are now indicated by the greater or less frequency of the light (nearly white) crystals of feldspar. The rock was fragmental originally, so far as outward characters indicate its original condition, but now is crystalline by metamorphism, the force producing the metamorphism having acted so powerfully as to cause a plastic if not a fused state of the constituents.

At a point a little to the west (across the strike) from where 1062 was obtained this rock is more plainly a conglomerate, and not so generally porphyritic.

On the point, S. E. side of sec. 29, 65-6, Kekebabic lake, the exposed rock is hardened and reformed by metamorphism from the slates and conglomerate. It was pebbly and fragmental originally, but greenish, nearly homogeneous, basaltic and apparently eruptive now. No. 1093 represents the finer portion of the rock.

Ogishke Muncie lake. On the north shore of the long bay from Ogishke Muncie lake, N. W. ¼ of sec. 27, 65-6, the slates and graywackes are conglomeritic (1063), the latter being sometimes quartzytes. These finely conglomeritic beds are separated by dark, light-weathering, laminated, slaty argillitic rock in bands

of about the same width (3 to 10 inches), and have a S. S. E. dip about 75°. Yet all round this bay this great conglomerate prevails on the east and west sides rising in hills 20 to 30 feet high, coarsely jointed, and not presenting the banding that indicates the bedded structure of sedimentation.

No. 1064 fairly represents this conglomerate about this bay. In places it is simply a dark, tough, doleryte-like rock with igneous jointage, and in others (1065) it is porphyritic and conglomeritic, containing flint, jasper and quartz in foreign pebbly masses.

At the narrows going out from this bay, near the centre of sec. 27, 65-6, the same conglomerate is found, but here it has less the eruptive appearance. The graywacke beds are rather a gray quartzyte, sometimes pebbly, and make up the most of the whole, the only sign of bedding due to sedimentation being a banding that is produced by more pebbly belts (running E. and W.) and a linear grooving on the non-pebbly belts caused by the weathering out of some of the elements faster than others. The whole mass can be said to be a quartzyte and conglomerate.

The pebbles included can be identified as follows: Flint; porphyritic flint, or felsyte (both being gray unless weathered); quartzose, light-colored granulyte; white quartz (both limpid and milky); diabase (fine); diabase (coarse); and banded jasper (red). The light-colored granulyte and the doleritic rocks form the largest included masses and are most numerous.

At the shore, on Ogishke Muncie lake, a little west of north from Campers' island, the fragmental conglomerate is basaltic at the water, and rises about fifteen feet nearly perpendicular. On the top of the hill can be seen a banding of sedimentary structure, consisting of alternations of coarse and fine belts, dipping south, 65° from the horizon. It is also evident by the contorted flowage structure brought out by weathering on the upper surface, that the whole mass has been plastic, the sedimentary bands being obliterated or broken, and in their place substituted a slow-bending and undulating set of fine striations that turn on themselves and change direction when abutting against some other masses that are banded with sedimentation.

At a point a little further east the same rock rises about 35 feet in the same way.

East of the central narrows, which are in the south part of sec. 23, 65-6, on the north shore, N. E. ¼ of the S. E. ¼ of sec. 23, 65-6, the slate and quartzytes stand vertical, or dip north 80°.

A basaltic conglomerate appears again on the north shore S. W. ¼ of the N. W. ¼ of sec. 24, 65-6.

Along the second narrows, on the east side, and south of the narrows, is a curious condition of the conglomerate. It is schistose, almost fissile, and small chips roll down the bank not larger than ½ inch or 1½ inches in diameter. These cover the undisturbed rock surface from the water upward. In some places the rock stands out entire. When it is wholly disintegrated the thin rusty chips are from ⅛ to ½ inch in thickness, making the bluff look like one of drift. On the top (1067) the rock is coarsely disintegrated by wedge-making joints. It is here also greenish, and finely porphyritic in the matrix, yet pebbly and sometimes more firm. There seems to be a chloritic element produced in the matrix by change from some original mineral.

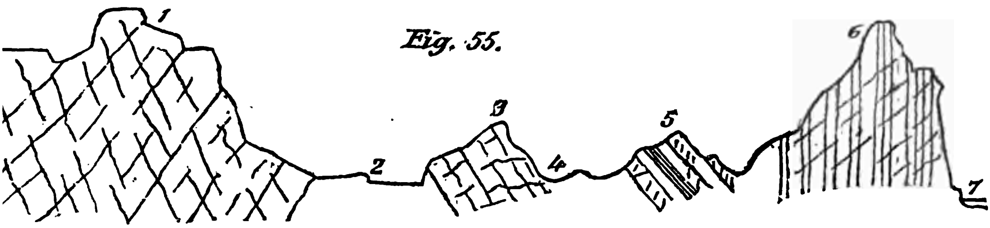


Fig. 55.—*Section across the shore of Ogishke Muncie lake.*

The above diagram is a section across the shore of Ogishke Muncie lake, a little north of the second narrows, on sec. 24, 65-6, east side.

1. Doleryte, scantily conglomeritic. At other places along here this is abundantly porphyritic, and then weathers into a rusty schist.
2. Swampy. No exposure.
3. Carbonate of iron (and calcite?). This is the same as No. 746, obtained further west in 1879. It runs here in a low rusty ridge, holding angular pieces of siliceous loose rock which stand out on the surface. This ridge extends in the direction toward that seen in 1879, and here rises about 10 feet. It seems likely to be of the nature of vein-deposits. Its thickness here may be fifteen feet, but it embraces considerable schistose foreign matter.
4. Swampy.
5. Gray quartzyte, fine-grained, rises ten feet.
6. Slates, sedimentary, standing vertical, the slates being due to sedimentary bedding; interstratified with some coarser beds that are more like the gray quartzyte. Rises 20 feet.
7. Lake level.

The whole distance across from No. 1 to No. 7 is about ten rods.

No. 1 is represented by rock 1068, and No. 3 by rock 1069.

At the rapids where the stream goes out from Ogishke Muncie lake to Town Line lake, the rusty schistose conglomerate No. 1068, appears in the water and causes the riffle. (No. 1070.)

About Frog Rock lake the rock, so far as examined, is entirely of the igneous doleritic kind, slightly conglomeritic, except at one place on the north shore where the sedimentary rocks appear, and are slightly conglomeritic. This last is near the N. W. corner of the lake. This lake was not thoroughly examined, but according to what is known the green doleryte would run along the southern side and past the eastern end. The rock of the principal point projecting northward from the south shore is represented by No. 1071, being a porphyritic, greenish rock (a diabase) with crystals of some pyroxenic mineral, resembling 1059. At the extreme east end of the lake appears 1072, a fine-grained greenstone, with pyrites.

At the mouth of the stream which enters Ogishke Muncie lake from the south was taken the following diagram. Fig. 56:

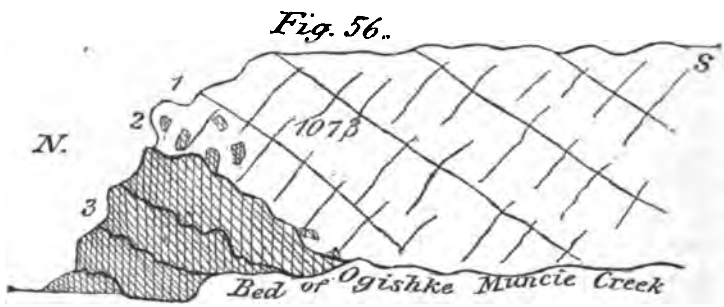


Fig. 56.—*Diagram of a superposition of rocks at the mouth of Ogishke Muncie creek.*

1. An overflowing rock, having the jointage, action and aspect of an eruptive rock. 1073.

2. Irregular stratum of the same holding fragments of fissile, closely jointed, baked slate which is thin and black, and crumbles in the slope, of which 1074 is a sample. Rock No. 1075 shows the contact of these two rocks, and the consequent blending of characters.

3. Fissile black slate, closely jointed, baked, separated into thick beds, the upper and lower sides of which undulate, the general dip appearing to be S. E. but so faulted and twisted that it can not be determined. The whole slate exposed is about fifteen feet, and the overlying rock rises about ten feet higher at the place of the diagram, but it spreads generally over the surface at some little distance back from the shore. It also extends westward, across the creek, and then spreads about over a distance of some rods, making some little hil-

locks, and is porphyritic (1078). The slates underlying are highly changed, sometimes wholly fused, or brecciated, and uniformly converted to a very closely jointed or fissile, fine (cherty) rock.

In going upward from here to the hills in sec. 35, 65-6, on the west side of the creek the following facts were noted: (1.) The sedimentary slates and quartzytes are broken, and dip in various, but nearly vertical, directions. (2.) The sedimentary beds become porphyritic with feldspar crystals, and apparently with some quartz crystals. (3.) They acquire a fluidal bedding, seamed and veined by quartz. (4.) They strike north, 20° W.; N.; N. 28° W.; N. 20° E., and generally dip E. or S. E. or S., toward the mountain, but their strike on weathered surfaces is often contorted, like the graywacke at Tower, and fragments are mixed with other kinds of beds, the beds apparently bending round them. (5.) So far as observed they are always full of free quartz grains, even in their apparently igneous outward aspects. The weathered surface is light-gray—or graywacke-like. (6.) Further up, at three-fourths of a mile from the lake, the strike is west 25° north, and the dip is 80° to 85° toward the S. W. (7). At the distance of nearly a mile from the lake, at 145 feet above it, the change illustrated by the accompanying diagram (Fig. 57) takes place. Here the sedimentaries dip N. at an angle of 50° from the horizon, 40° east, lying on the greenstone illustrated by sample No. 1076. On the top of this hill are scattered boulders of Saganaga granite, etc.

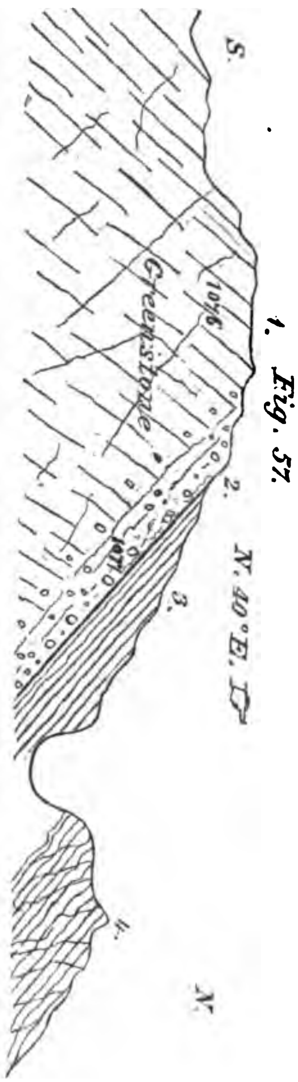


Fig. 57.—Showing the position of the slates and quartzytes relative to the greenstone on sec. 35, 65-6.

EXPLANATION OF FIG. 57.

1. Greenstone, apparently forming the mountain to the south, rock No. 1076, at 145 feet above Ogishke Muncie lake. This rock is tough, massive, and coarsely jointed.

2. Pebbly greenstone, 3 to 5 feet. Rock 1077. On the surface the line of contact, which, facing north, is glaciated, shows very distinctly, and the pebbles seem to be all of greenstone, or at least of some greenish rock, some of them quite fine-grained. The line of contact is shown by the next figure.

3. Hard, fine-grained, almost cherty, but black, beds of slate in distinct sedimentary arrangement.

4. Broken and contorted graywacke and slaty bed, seen about ten feet.

Fig. 58.

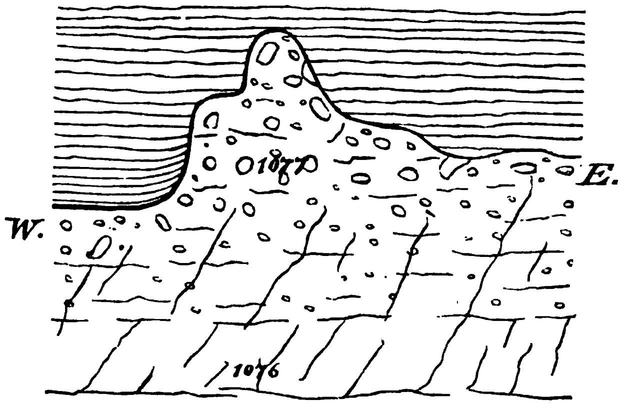


Fig. 58.—*Plan of the surface showing the line of contact at fig.* 57.

This superposition is believed to be accidental, and one of the local over-turn dips that accompanied the upheaval of the formation. The numerous other observations already given on the direction of dip of the quartzyte and slate series in this mountain show the frequent changes of direction to which it is liable. The correct stratigraphic sequence will require the quartzyte and slate rocks below the gabbro—if not below this greenstone.

We ascended only to a spur of the main hill, rather lying between the two hills that are in sec. 35, 260 feet above the lake. The hill which lies about half a mile further south seems to rise about a hundred feet higher, or 350 feet above Ogishke Muncie lake. The same rock as 1076 continues to and forms that hill, as ascertained in 1879.

No. 1079 shows a fair sample of the matrix of the Ogishke con-

glomerate, a third of a mile from the shore north from Campers' island, and 1079 A are pebbles from the same, i. e. near the centre of sec. 23, 65-6.

Near the N. E. corner of the S. E. ¼ of sec. 22, 65-6, the conglomerate is porphyritic with crystals of white and flesh-red feldspar (1080). But these may be only transported fragmental grains, which is indicated by the fact that they are somewhat rounded occasionally and are disseminated through a coarse, granular matrix in which are numerous rounded grains of quartz of about the same size, some fine red jasper, greenstone, and the other usual ingredients of the conglomerate. Sometimes, in a simply arenaceous portion of the matrix, or one of the uniformly but heavily bedded portions, the little points that stand out on a weathered surface are partly of feldspar crystals, and partly of quartz.

At about a mile and a quarter northwest from the same place on the shore, the formation ceases to be of conglomerate, and becomes prevailingly a siliceous black slate (1081), similar to that seen in sec. 26, 65-6, a short distance south from the south shore. About eighty rods further northwest an arenaceous texture appears in these hard flinty slates, and they are thicker bedded, though still separated by fine slaty layers. These heavy beds become greenish, and at the hill which is on the west side of the N. E. ¼ of sec. 22, they become converted into a greenish arenaceous graywacke that recalls the rock of the mountain south of Ogishke Muncie lake, but can not be the equivalent of that because this is fragmental, showing rounded jasper and quartz grains; it is also lighter-colored, its green color being due to its green matrix. At the summit of this hill it is evident that rock 1082 constitutes the bulk of the hill; but even here it is intersected by beds of 1083, a flinty "slate," greenish black, hard and finer than diabase. This is in bedded alternation with 1084—the same as 1082, a really fragmental rock.

Trip to lake Gabimichigama. From the west side of Little Reynard lake (which is between Ogishke Muncie and Fox lakes) was obtained rock No. 1085, near the water. This is a fragmental rock, even a conglomerate with pebbles of quartz and flint, evidently a part of the same great conglomerate, but it is blackened and hardened and changed, the quartz being the only original pebbly element that retains its form and distinctness. The flint and the red jasper are also nearly as perfectly preserved. This suggests the important inquiry whether by fusion this conglom-

erate could be converted to the rock of the hill 1076—a perfectly characterized igneous rock—through the stages of the rocks 1073 and 1082. It is not probable, but at numerous places about the lake observations that have been made give rise to such a query.

On the N. W. side of Fox lake the slates and quartzytes are wholly broken and confused. The bedding is lost, and the rock appears almost igenous-massive. It is here mainly a changed black slate, there being now no suggestion, even, of its original condition (1086), an aphanitic, black petrosilex (?), or chert.

On the portage from Fox lake to Agamok lake the formation is not only beautifully and continuously long banded by alternating belts of slate and chert, but is also beautifully brecciated, the pieces of slate being of all sizes, from an inch or two to several feet long, inclosed in the coarser-grained graywacke, running zigzag and in isolated dike-like protrusions.

At the foot of Fox lake the north bluff stands up boldly above the water, consisting of a hardened and pseudo-basaltic, but coarsely jointed, condition of the quartzyte and slate formation. It is represented by fig. 59.

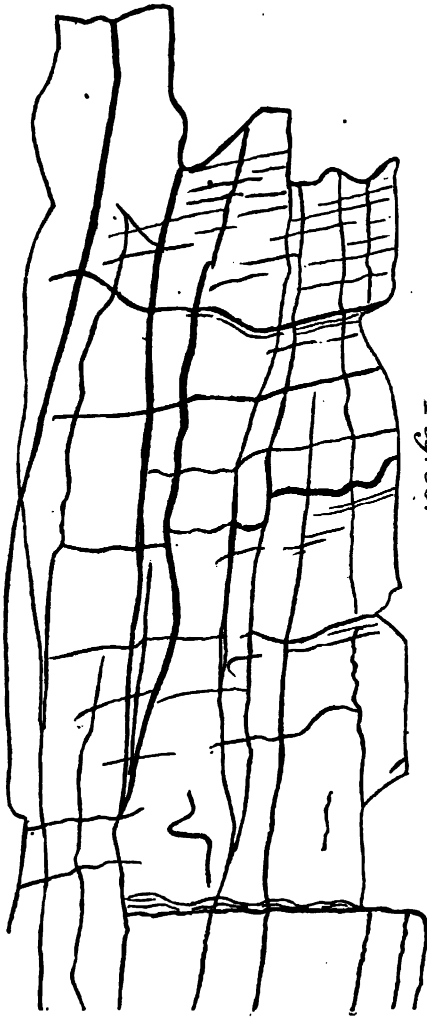


Fig. 59.

Fig. 59.—*Bluff at the foot of Fox lake, showing jointage in the hardened quartzytes and slates.*

In Fig. 60 (next page) the dark lines represent cherty, light-weathering beds; the white bands represent the interlaminated coarser beds. The mixture of crumpled and straight beds, seen in immediate contact and alternation, is the interesting and puzzling fact here. Many of the beds are so thin that they are no thicker than the pencil point, and on this reduced scale they can not be represented—nor one half of them. No. 1087 shows this rock when brecciated. The slates, being more refractory,

do not lose their identity in the general mixing and metamorphosing process.

Fig. 60.

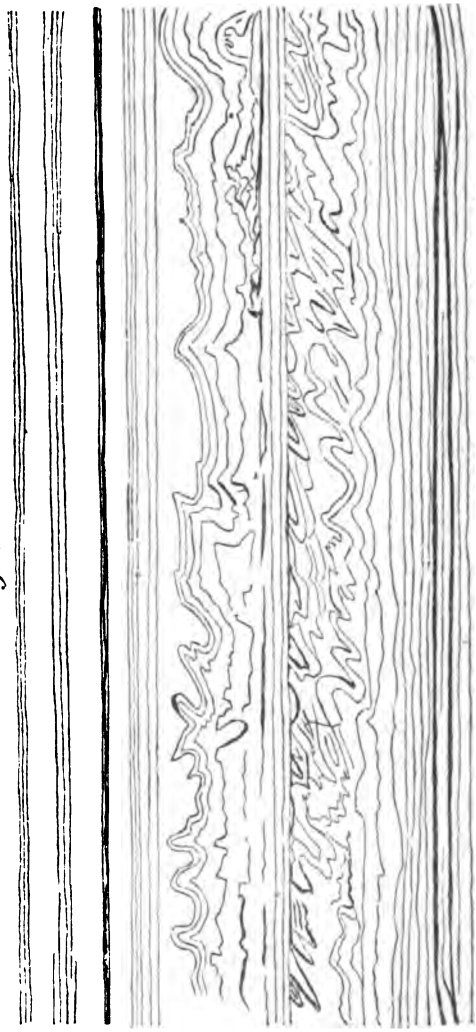


Fig. 60.—*Sketched from the surface, on the portage from Fox to Agamok lake; alternate straight and contorted bedding in immediate contact.*

Along the north shore of Gabimichigama lake in 65-5 the quartzyte-slate formation is seen in occasional low exposures. jointed closely and greatly changed, rarely pebbly, vertical (so far as can be ascertained) striking nearly N. and S. or N. N. W. and S. S. E.

The little island at the entrance to the bay forming the north-

easterly end of Gabimichigama lake contains this formation, and is represented by rock 1088. This rock is a rather fine-grained, arenaceous gray quartzyte. It shows no outward evidence of stratification. It takes a rusty color. It presents knobs and ridges all over the surface, that do not weather away so fast as the rest. It appears like some of the craggy rock that lies near the gabbro-contact at the S. W. end of Kekekabic lake.

At the west side of sec. 32, 65-5, the rock of the long point that projects westerly into the lake is not well exposed on the north shore. A bluff, however, rises, about midway of the point, and is composed of coarsely jointed heavy layered rock that shows a general structure dipping east about 45 degrees (1089). This is a siliceous, very much hardened fragmental rock, but its original sedimentary banding is obliterated by the action of the formerly superposed overflowing gabbro. It is the same as No. 1088, but shows an intenser action of the gabbro on the quartzyte and slate group.

On the south side of this point appears a fine biotitic gneiss (1090). This is apparently siliceous (with some grains of quartz) but in the main no quartz can be distinguished with certainty. Sometimes it appears chrysolitic. It is heavy-bedded, resembling in outward appearance the rock 1089, and dips also toward the east, at an angle of 30 to 45 degrees, this bedding, however, being due to a wavy system of planes separating it into sheets, and not to any variation in the rock such as is implied by sedimentation. This holds boulders of quartzyte, and apparently of other kinds of rock, but they are so assimilated to the enclosing rock that they are individually now unidentifiable. This rock crumbles in some places, allowing apparently boulder-masses to roll out; in such cases some of the glassy grains are yellowish, and indicate the presence of chrysolite, as mentioned above. Sometimes the whole of it takes the form of "muscovado" gabbro—which is a semi-disintegrated condition. The whole bluff along here seems to be on a parallel with that which was noted in 1879 on the south shore of this lake further west (rocks 767 and 768).

Fig. 61 represents a map and concordant profile section east and west along the south side of this point. It shows the irregular manner of bedded structure mentioned in 1090, and appertains to the outrunning overlie of the gabbro on the quartzyte-and-slate group.

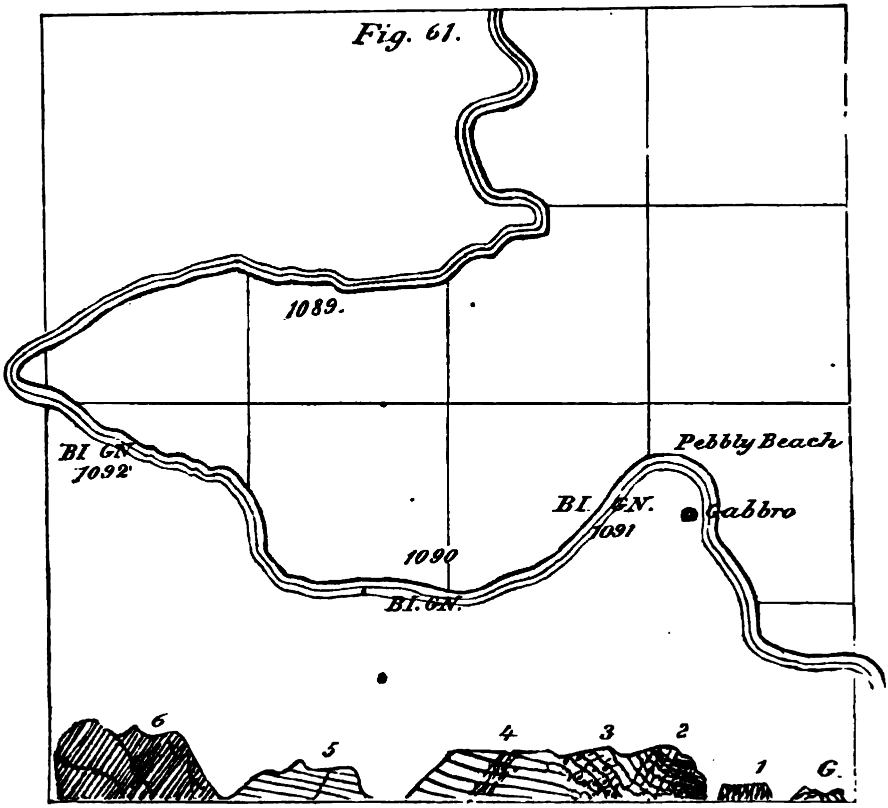


Fig. 61.—*Showing the gneissic, and yet bedded, structure of all the rocks at the bottom of the gabbro sheet.* Sec. 32, 65-5.

Explanation of Fig. 61.

G. Gabbro island. Gabbro appears in force along the lake further south.

1. Biotitic gneiss; confused, with no bedding nor strike, but apparently holding boulders greatly changed, all being siliceous. The prevailing jointage is vertical, and runs 25° W. of N. This has much the general aspect of some changed portions of the quartzyte-slate group, seen on the north side of this point.

2. Biotite gneiss, siliceous, irregularly jointed and disintegrating.

3. The formation here is siliceous and biotitic, but the biotitic portions are in streams, which, surrounding portions that are less micaceous and more siliceous and firm, disintegrate, disclosing boulder-like masses that fall out like "boulders of disintregation." There is now and then a striation that reminds one of the banding of sedimentation, as if a modified part of the quartzyte-slate formation of this region.

4. Here the grand bedding dips conspicuously toward the east. Along the water, generally, this rock has a knobbed rough upper surface, eroded by the action of the waves on the more or less micaceous parts. There is here a closely jointed portion that runs about N. E. and S. W. but slopes N. W.

5. Shows a plain-bedded dip eastward; micaceous and rotting.

6. At the end of the point the rock rises perpendicular and exhibits a plain sedimentary banding that dips W. 10° S. running from the water to the top of the bluff. This is a part of the underlying quartzyte-and-slate series. It is siliceous in bands, but throughout it are scattered fine mica scales.

This traced transition from the quartzyte-slate rocks to biotitic gneiss, and hence to the biotitic diabase (so called on the Kawishiwi river) in the immediate vicinity of the gabbro boundary, is an important step in establishing the genetic relations of these formations. There is here, however, nothing to be seen of the great greenstone formation which extends east and west through the country. That seems to lie further north, while this shows the gabbro contact without the greenstone accompaniment, direct on the quartzyte and slate group (the Animikie series), and the greenstones lie, at the west end of Gunflint lake, to the north from the south-dipping Animikie, it seems to agree with a large number of facts to suppose the Animikie series lies on the greenstone, or in its absence, on the Saganaga syenite. The westward extension of the superficial area of the Animikie seems to be cut off by the overlopping of the gabbro beyond its northern border, bringing the gabbro not only onto the greenstone, but at points further west onto the lower graywacke-slate series. This would place the Animikie series stratigraphically between the gabbro and the greenstone; and the greenstone would represent an overflow of basic eruptive rock much anterior to that of the gabbro. The Ogishke conglomerate is allied closely with the Animikie. It contains numerous greenstone boulders, and perhaps represents its basal portions.

North and west from Kekekabic lake. In making the portages from Kekekabic lake to Knife lake, the principal part of the descent being at the north ends of the portages, and the whole descent being 135 feet, each trail discloses only the graywacke-slate rock, sometimes greatly broken and seamed and at first rather greenish. On Spoon lake there seems to be a dike, forming at least two of the islands, cutting graywacke and slate.

Just at the north of the portage landing on Knife lake, near the west side of sec. 27, 65-7, is a light weathering knob of black or purplish flint (1107), belonging to the same formation as seen on the other side of Ogishke Muncie lake. But the graywacke-

slates appear before reaching the west end of Knife lake. The line of travel after entering Knife lake is nearly in the line of strike of the rocks of the region, and hence there is a sameness in the appearance of the rocky outcrops. The strata are from two inches, or less, for the argillitic portions to six inches, and even six feet, for the coarser beds. They are almost invariably either vertical or dip at a high angle toward the S. S. E.

5. THE GENERAL GEOLOGICAL MAP.

The preliminary geological map which accompanies this report is intended to show what is known concerning the geological boundaries, and also includes considerable that is guessed at. Wherever the reports describe the formations, they are known, but there are long distances that intervene between known points. Perhaps there is less certainty concerning the areal distribution and the stratigraphic relations of the greenstone belt (No. 6 of the legend of the map) than any other of the formations, and greater certainty of the correctness of the northern limit of the gabbro. The area of conglomerate and felsyte extending eastward from the southern confines of Vermilion lake may be continuous and identical in origin with the greenstone belt, but there are unsettled points that need investigation before such a connection could be affirmed. The graywacke and sericitic schist rocks are represented as covering this doubtful area.

There will be found also many variations necessary to be made from the regularity of the outline of the red syenite and which is involved with the gabbro in the eastern part of the map. The granite, syenite and gneissic areas are all represented by the same color, but this is not intended to express the idea that they are of the same age. The northern limits of the red quartz porphyry (No. 4) are uncertain. It is possible that there is no gabbro nor trap separating it from the red syenite further north, and that it will be found to blend into the red syenite, this being one form of metamorphism of a sedimentary rock and the red syenite another.

6. BAROMETRICAL ELEVATIONS.

Determined by aneroid readings by N. H. Winchell in August, 1886:

Garden lake above Fall lake ....60 feet.		White Iron lake above Fall lake, 90 ft.
Ascent by river (estimated)........ ......10 feet.		
Further ascent to White Iron lake (estimated) ....20 feet.		
Ascent by portage from White Iron lake to the river in sec. 19, 62-11.........25 feet.		Above Fall lake 115 feet.

The water passing here is about the same as that at the outlet of Vermilion lake.

Ascent by rapids to Birch lake, in sec. 6, 61-11 (estimated)	15 ft.	
Birch lake above Fall lake..............................		130 ft.
Ascent by rapids, in the East Branch of Birch river.		
" N. E. ¼ of sec. 27, 62-11.....................	16 ft.	
" S. E. ¼ of sec. 22, 62-11.....................	3 ft.	
" S. W. ¼ of sec. 23, 62-11	5 ft.	
" N. part of sec. 23, 62-11......................	5 ft.	
" N. E. ¼ of the S. W. ¼ of sec. 24, 62-11	5 ft.	
" Foot of Copeland's lake....................	6 ft.	40 ft.
Copeland's lake above Fall lake.........		170 ft.
" Head of Copeland's lake, S. E. ¼ sec. 6, 62-10...	8 ft.	
" S. W. ¼ sec. 4, 62-10	1 ft.	
" S. E. ¼ sec. 4, 62-10...........................	8 ft.	
" N. W. ¼ sec. 3, 62-10..........................	3 ft.	
S. E. ¼ sec. 26, 63-10 (Fork of the Kawishiwi)	3 ft.	23 ft.
Fork of the Kawishiwi above Fall lake		193 ft.
Ascent by Archway rapids, sec. 9, 62-10.............	25 ft.	
" Rapids in N. W. ¼ sec. 16, 62-10.........	4 ft.	29 ft.
Gabbro lake, above Fall lake........		222 ft.
Ascent by rapids, S. W. ¼ sec 23, 62-10...............	4 ft.	
Bald Eagle lake above Fall lake........................		226 ft.
Estimated ascent to lake Isabella.....	100 ft.	
Isabella lake above Fall lake............................		326 ft.

Ascent from the fork of the Kawishiwi:

Rapids S. E. ¼ sec. 24, 63-10..............................	6 ft.	
Rapids S. W. ¼ sec 19, 63-9...............................	10 ft.	
Rapids S. E. ¼ sec. 17, 63-9...............................	4 ft.	
" N. E. ¼ sec. 20, 63-9...............................	9 ft.	
" S. E. ¼ sec. 20, 63-9...............................	2 ft.	
" S. E. ¼ sec. 20, 63-9...............................	4 ft.	35 ft.

Crab lake above Fall lake		228 ft.
Ascent from Crab lake:		
Rapids in N. E. ¼ sec. 28, 63-9	10 ft.	
Further ascent. Rapids in N. E. ¼ sec. 28, 63-9	10 ft.	
Rapids S. E. ¼ sec. 30, 63-8	8 ft.	
Rapids N. E. ¼ sec 31, 63-8	15 ft.	
Rapids N. W. ¼ sec. 32, 63-8	3 ft.	
Rapids N. W. ¼ sec. 34, 63-8	18 ft.	64 ft.
Wilder lake above Fall lake		292 ft.
Fall lake above lake Superior*	810 ft.	
Lake Superior above the sea	602 ft.	1,412 ft.
Wilder lake above the sea		1,704 ft.
Sec. 3, 63-11. Newton lake below Fall lake, by rapids		10 ft.
Pipestone rapids, Basswood lake below Newton lake		6 ft.
Carp lake above Basswood lake		12 ft.
Cap lake above Carp lake		6 ft.
Ensign lake above Cap lake		1 ft.
Illusion lake above Ensign lake		160 ft.
Ima lake above Illusion lake		20 ft.
Enlargement of the stream entering Ima lake above Ima lake		6 ft.
Small lake just below the outlet of Thomas lake, above the enlargement		12 ft.
Thomas lake above the small lake mentioned		3 ft.
Fraser lake above Thomas lake		1 ft.
Wisini lake above Fraser lake		5 ft.
Syrup lake above Wisini lake		25 ft.
(Wisini and Syrup lakes are in sec. 14, 64-7.)		
Shoe-fly lake above Syrup lake		0 ft.
Lake in the river, sec. 11, 64-7, below Shoe-fly lake		1 ft.
Kekekabic lake below lake in the river		95 ft.
Descent from Kekekabic lake to lake No. 1	4 ft.	
" from lake No. 1 to lake No. 2	25 ft.	
" from lake No. 2 to lake No. 3	15 ft.	
" from lake No. 3 to lake No. 4	2 ft.	
" from lake No. 4 to lake No. 5	12 ft.	58 ft.
Ascent from No. 5 to lake No. 6		18 ft.
Descent from No. 6 to Ogishke Muncie lake		6 ft.
Ogishke Muncie lake below Kekekabic lake		46 ft.

*Ninth annual report, p. 9.

Estimated ascent from Ogishke Muncie lake to Little Reynard lake (an enlargement of the river)..	4 ft.	
Further ascent to Fox lake, S. E. ¼ sec. 26, 65-6	45 ft.	
Ascent (through several little lakes) to Agamok lake..	45 ft.	
Ascent to Gabimichigama lake	4 ft.	
Gabimichigama lake above Ogishke Muncie lake..		98 ft.
Descent from Kekekabic lake to Pickle lake.....	35 ft.	
" Pickle lake to Spoon lake...........	30 ft.	
" Spoon lake to Doughnut lake......	40 ft.	
" Doughnut lake to Knife lake......	30 ft.	
Knife lake below Kekekabic lake..................		135 ft.
Descent from Knife lake to Potato lake	18 ft.	
" Potato lake to Seed lake............	14 ft.	
" Seed lake to Melon lake............	8 ft.	
" Melon lake to Pseudo messer lake	10 ft.	
" Pseudo-messer lake to Sucker lake	28 ft.	

7. GLACIAL STRIÆ OBSERVED BY N. H. WINCHELL.

	True Meridian.
At the Lee mine, east end of the south ridge on jaspilyte..	S. 10° W.
[Exactly across the general trend of the ridge.]	
At the east end of the south ridge near the top, on jaspilyte..	S. 22° W.
At ¾ mile south of Tower, on graywacke (Jones)......	S. 24° W.
At centre of N. E. ¼ of sec. 3, 61-16 (S. side of Jones bay). Graywacke..	S. 20° W.
At S. E. ¼ of N. E. ¼ sec. 3, 61-16 (near the last). Poroditic graywacke..	S. 18° W.
At centre of sec. 17, 62-15, near W. end of Ely Island. Graywacke..	S. 22° W.
At centre sec. 26, 62-16. Black slate....................	S. 20° W.
At S. E. ¼ sec. 9, T. 62-16. Sericitic slate..............	S. 22° W.
At corner post of secs. 7, 8, 17 and 18, 62-16. Green schist..	S. 24° W.
At S. W. ¼ of the S. E. ¼ of sec. 19, 62-15. Felsitic conglomerate..	S. 17° W.

	True Meridian.
At S. E. ¼ sec. 5, 62-16. Sericitic rock...........	S. 19° W.
At S. W. ¼ sec. 6, 62-16. Dark schist....................	S. 22° W.
At N. E. ¼ sec. 11, 62-17. Hydro-mica schist	S. 28° W.
At N. E. ¼ sec. 32, 63-16. Mica-schist...................	S. 22° W.
At S. E. ¼ sec. 27, 63-16. Micaceous graywacke......	S. 22° W.
At S. E. ¼ sec. 6, 62-15. Graywacke	S. 18° W.
At S. E. ¼ sec. 4, 62-15 (on the island). Graywacke.	S. 20° W.
At centre of sec. 17, 62-15, west end of Ely island. Felsyte..	S. 22° W.
At S. E. ¼ S. E. ¼ sec. 17, 62-15, west end of Ely island. Felsyte...	S. 22° W.
At S. W. ¼ sec. 17, 62-15, west end of Ely island.....	S. 18° W.
Centre of sec. 4, 62-15. Graywacke......................	S. 20° W.
At the east end of Stuntz island. Felsyte.............	S. 23° W.
S. W. ¼ of sec. 20, 62-15. Graywacke..	N. and S.
S. W. ¼ sec. 24, 61-12. Gabbro........................ ..	S. 12° W.
N. E. ¼ sec. 31, 61-12. Syenite............................	S. 22° W.
S. E. ¼ sec. 30, 63-8. Gabbro	S. 8° E.
N. E. ¼ sec. 35, 63-9. Gabbro..............................	S. 12° W.
N. W. ¼ sec. 27, 63-10. Gneissic graywacke	S. 15° W.
Sec. 23, 65-10. Northeast cape. Gneiss................	S. 15° W.
Sec. 18, 64-7. North shore of Ima lake. Gabbro...	S. 36° W.
Sec. 18, 64-7. North shore of Ima lake. Gabbro...	S. 23° W.
Sec. 28, 64-7. Island in Thomas lake. Gabbro......	S. 25° W.
Sec. 11, 64-7. Gabbro...	S. 30° W.
Sec. 29, 65-7. Knife lake. Graywacke...........	S. 48° W.

6. CATALOGUE OF ROCK SAMPLES COLLECTED BY N. H. WINCHELL IN 1886.

864. Hard schistose rock or graywacke, south side of Jones bay in Vermilion lake, N. E. ¼ of sec. 3, 61-16.

865. Gray quartzyte, from the point near the S. W. ¼ of sec. 34, 62-16.

866. Brown jasper and hematite from the jasper ridge, sec. 29, 62-15.

866 A. Nodules from the above ridge, sec. 29, 62-15.

866 B. Gray fine quartzyte, from S. W. end of the same ridge, 100 feet above Vermilion lake.

867. Lighter colored quartz rock banded with jasper and with hematite, same ridge, sec. 29, 62-15.

868. Massive or basaltiform chloritic syenite, from a low ridge just southeast of last, sec. 32, 62-15.

868 A. Rhomboidal piece showing rough granular weathered surface; same exposed surface.

868 B. Shows the gneissic structure sometimes seen in 868; same locality.

868 C. Quartz from a vein, inclosing green chlorite and having a schistose structure; same exposed surface.

868 D. Contains a piece of chlorite from a fissure and a grain resembling a changed crystal of feldspar; same locality.

868 E. Nearly typical form of 868 obtained south of small ridge, near the west end.

868 F. Gneissic or schistose structure of 868, adjacent to 868 E.

868 G. Sericitic schist, same exposed surface with 868 E.

868 H. Arenaceous sericitic schist, same locality.

868 I. Black slaty jaspilyte, same exposed rock surface.

There is probably an unconformable junction between 868 H and 868 I.

869. Sericitic schist, from S. E. side of same ridge, sec. 32, 62-15.

870. Sericitic or clay slate, graduating into 869, sec. 32, 62-15.

871. Iron ore from the Lee mine, sec. 33, 62-15.

871 A. Crystals of hematite from same locality.

872. Fine-grained doleryte or dike rock, from Stuntz's island, sec. 21, 62-15.

873. Greenish chloritic schist from another set of dikes on same island, sec 21, 62-15.

873 A. Rounded ball of green rock from the schist No. 873 on Stuntz's island.

874. Conglomerate from Stuntz's island, sec. 21, 62-15.

874 A. Pebbles from same conglomerate, same locality.

874 B. Olivinic greenstone, found in 874, near some quartz veins, Stuntz's island, sec. 21, 62-15.

875. Sample of dike in southern part of sec. 12, 62-15.

876. Iron ore from the Tower mine, sec. 27, 62-15.

877. Sample of greenstone dike on Menan island, sec. 36, 63-17.

878. White granite and syenite from dike on Menan island, sec.36, 63-17.

879. Somewhat firm and gneissic mica-schist, ¼ mile from S. side of sec. 14, 63-17.

880. Lenticular syenitic-like nodules embraced in the mica schist, No. 879, sec. 14, 63-17.

881. Rather fine greenstone, from dike in north part of sec. 35, 63-16.

882. Coarsely schistose greenish rock, from the point projecting northward from sec. 35 into the N. W. ¼ of sec. 36, 63-16.

883. Fissile sericitic schist, N. E. ¼ of sec. 5, 62-15.

884. Cream-white sericitic (?) schist from Breitung mine, sec. 27, 62-15.

885. Sericitic-like rock, ½ mile from railroad cut, S. E. corner of sec. 5, 61-15.

886. Variety of 885 resembling a graywacke, southern end of same cut.

887. Graywacke, S. E. ¼ of sec. 8, 61-15.

888. Graywacke slate from same locality.

889. Pebbly sericitic schist, point, S. E. ¼ of sec. 20, 61-15.

890. Baked schist, from Stone mine, sec. 27, 62-15.

891. Finely banded rock resembling jaspilyte, from the same locality.

892. Rough, scarcely banded jasper, north wall of Stone mine, sec. 27, 62-15.

893. Rigidly slaty jaspilyte, south wall of Stone mine, sec. 27, 62-15.

894. Jaspilyte passing into greenish schist, near railroad cut in Ely mine, sec. 27, 62-15.

895. Transition between the schist and the jaspilyte, without pyrite, same locality as last.

896. Arenaceous schist with rounded (?) grains, railroad cut in Ely mine.

897. Lenticular jaspery and chalcedonic quarzyte, embraced in green schists, Ely mine, sec. 27, 62-15.

898. Two other examples of blending of the schists and jasper, obtained near Tower; exact locality uncertain.

899. Weathered piece of jaspilyte, with crystals of pyrite, obtained near Tower.

900. Same, but containing fine rhombohedra of magnetite, near Tower.

901. Baked clay, near the contact with the jaspilyte; Lee mine, sec. 33, 62-15.

902. Pure red jasper, from the Stone mine.

903. Red jasper, with darker bands of iron ore, Stone mine.

904. Siliceous nodules, from the "baked clay;" Stone mine.

905. Banded specular hematite, Stone mine.

906. Iron ore breccia, same locality.

907. Greenish, finely striped jaspilyte from the Stone mine.

908. Matrix of conglomerate occurring north of the Cady House near Tower.

908 A. Fragments of boulders derived from 908.

909. Hematitic jasper and white or nearly white quartzyte, near Tower, a little to the north.

910. Sericitic schist, from a narrow band between two jasper masses, near Tower.

911. Jasper conglomerate, sec. 20, 62-15.

912. Brecciated schist, cemented by sulphide of iron; Lee mine, sec. 33, 62-15.

913. Graywacke, from low hills S. E. of Tower, near the railroad, sec. 33, 62-15.

914. Porodyte, containing pebbles of graywacke, S. E. of Tower, near the railroad, sec. 33, 62-15.

915. Greenstone, from dike cutting the graywacke near the railroad, S. E. of Tower, sec. 33, 62-15.

916. Breccia, now converted to hematite and a floury white mineral; Breitung mine, sec 27, 62-15.

917. Jaspilyte, from extreme eastern extension of the ridge affording 868; sec. 32, 62-15.

918. Coarse quartz dioryte, from a boulder occurring near the railroad, at Breitung mine.

919. Green schist from the railroad cut south of the Stone mine, sec. 27, 62-15.

920. Graywacke, containing crystalline grains, S. E. ¼ of sec. 6, 62-15.

921. Black or purplish-black clay slate, S. W. ¼ of sec. 6, 62-15; lake shore of Pine island.

922. Fine, tough, granular basaltiform graywacke, shore, S. W. ¼ of sec. 1, 62-16.

923. Samples showing contact of mica-schist and syenite, centre of sec. 35, 63-17.

924. Granite from S. W. ¼ of sec. 35, 63-17.

925. Fine-grained mica schist, same locality.

926. Greenstone, N. E. ¼ of sec. 31, 63-17.

927. Granite, from the point, centre of sec. 23, 63-18.

928. Graywacke-like rock containing syenite in lenticular patches, S. W. corner of sec. 9, 63-17.

929. Mica-schist, not gneissose, N. E. ¼ of sec. 13, 63-18.

930. Gneissic mica-schist from same locality.

931. Reddish-gray gneiss, N. E. ¼ of sec. 13, 63-18.

932. Granite, coarsely crystalline, from the same locality.

933. Gneiss, interstratified in mica-schist, sec. 14, 63-18.

934. Intrusive granite, obtained at mouth of Rice river, so called, N. E. ¼ of sec. 15, 63-18.

935. Granite from a reef in N. W. ¼ of sec. 26, 63-18.

936. Granite somewhat gneissic, from the small island N. W. cor. sec. 32, 63-17.

937. Light-colored granite, from small island just east of Big Island, N. W. ¼ of sec. 22, 62-18.

938. Fine-grained mica-schist, from same small island, west side, N. W. ¼ of sec. 22, 63-18.

939. Green argillyte slate, somewhat crumpled, from the island in S. E. ¼ of sec. 31, 63-16.

940. Reddish granite, coarse, not very common, S. W. ¼ of sec. 23, 63-16. North shore of the bay.

941. Red granite from same place, rather common.

942. Red granite, finer grained than last, composing large bluff, same locality.

943. Red granite, lighter colored than 942, from same bluff.

944. Grayish granite, one of the common phases of the rock of the region, near centre of sec. 23, 63-16.

945. Micaceous gneiss, S. W. ¼ of sec. 23, 63-16.

946. Red micaceous gneiss, from N. E. ¼ of sec. 27, 63-16.

947. Porodyte graywacke, from S. W. ¼ of sec. 3, 62-15.

948. Schist, nodular, and resembling an igneous breccia. "Halt 160," N. W. ¼ sec. 28, 63-11.

949. Green diabase, cutting 948, from same locality.

950. Bedded quartzyte from the Silver City mines, N. E. ¼ sec. 32, 63-11.

951. Quartz in which the tunnel runs, somewhat disintegrated, same locality.

952. Coarse, red-weathering syenite, west side of White Iron lake, sec. 6, 62-11.

953. Coarse porphyritic syenite, river bank, sec. 19, 62-11.

954. Coarse gabbro, east side of Birch lake, on N. W. ¼ sec. 17, 61-11.

955. Granite, dark-colored and gneissic, N. W. ¼ of sec. 26, 61-12. From boulders.

956. Gneissic chlorite rock, containing feldspar and quartz, N. W. ¼ of sec. 26, 61-12. From boulders.

957. Altered olivine rock, same locality. From boulders.

958. Breccia of mica-schist cemented by granite, N. E. ¼ of sec. 21, 61 12.

958 A. Sample of the mica-schist last mentioned.

958 B. Shows the nature and actual width of one of the granite veins occurring in 958, from same locality.

959. Red-weathering bedded granite, bluff on shore of the lake, near ¼ sec. line, sec. 23, 61-12.

960. Ferruginous olivine rock, from a low ridge about 15 rods from shore, S. W. ¼ of sec. 24, 61-12.

961. Shows the contact between syenite 953 and the granite 955 and 957; from last mentioned locality.

962. Olivinitic gabbro, dark-colored, from about ¼ mile west of last.

963. Fine-grained red syenite, like the "red rock" of Grand Marais, near the point at the sec. line between secs. 23 and 24, 61-12.

964. Coarse porphyritic syenite, point on the coast, S. E. ¼ of sec. 22, 61-12.

964 A. Fine granular granite, from vein cutting across 964 and blending below with 965; same locality.

964 A. Mica-schist, in small patches, a phase of 964 A, same locality.

965. Fine-grained granite in regular beds, S. E. ¼ of sec. 22. 61-12.

965 A. Coarse syenite from zigzag vein (or dike) in 965.

966. Coarse syenite below 964 to 965 A inclusive, from same locality.

967. Fragment of dike-like rock cutting coarse syenite, from the bay, N. side of sec. 21, 61-12.

968. Coarse syenite, cut by vein of reddish fine syenite, short distance north of last, beyond N. line of sec. 21, 61-12.

969. Portion of dark vein crossing coarse syenite, S. E. ¼ of sec. 29, 61.12.

970. Fragment from same dike, or vein, showing tendency to become mica-schist; from same locality.

971. Portion of same dike, showing contact with the syenite, and here being, apparently, a true mica-schist; S. E. ¼ of sec. 29, 61-12.

972. Gneiss, sometimes passing into a fine-grained quartzose granite; from a little north of last locality, in same section.

973. Hornblendic gneiss, a phase of 972, from N. W. corner of sec. 30, 61-12.

974. Shows the same rock (972) undergoing a change toward mica-schist; from same locality.

975. Two other examples of 972, here a mottled schist from extreme west end of Birch lake, south of mouth of Birch river.

976. Olivinitic iron ore, from a boulder ¼ mile south of second crossing, S. W. ¼ sec. 10, 62-12.

977. Fine-grained olivine gabbro, from the second crossing Dunka river, S. W. ¼ sec. 10, 60-12.

978. Dioryte apparently passing into coarse red-weathering syenite, S. E. ¼ sec. 28, 61-12.

979. Fine syenite, taken from the Palisade rock of Archway rapids, sec. 9, 62-10.

980. Diabase-felsyte, from a small island in S. E. ¼ of N. W. ¼ sec. 19, 63-9.

981. Hard quartzose gneiss, from an island lying southeast from the last.

982. Biotite-olivine-gabbro, or biotite mica-schist, N. E. ends of little N. E. and S. W. lakes, secs. 15 and 16, 63-9.

983. Undecayed sample of the above. A phase of the real gabbro; same locality.

984. Quartzose gneiss, also a phase of the real gabbro; same locality.

985. Fine-grained gabbro with small percentage of biotite, near the river, S. W. ¼ sec. 16, 63-9.

986. Fine quartzose gneiss or mica-schist, north side of the river, N. W. ¼ sec. 20, 63-9.

987. Fine-grained diabase, from the hill in sec. 18, 63-9.

988. Gabbro, from the summit of a small ridge between the above hill and the shore, sec. 18, 63-9.

989. Fine-grained, slightly micaceous quartzose rock, N. W. ¼ sec. 27, 63-10.

990. Nearly white gneissic rock, shore of lake, north of last, N. W. ¼ sec. 27, 63-10.

991. Gray, red-weathering gneissic rock, from an island in the lake, N. W. ¼ of sec. 27, 63-10.

992. Red-weathering chloritic syenite, north shore of the lake, a little east of 991, N. W. ¼ of sec. 27, 63-10.

993. Chloritic syenite similar to 992, but closely and lenticularly jointed, N. W. ¼ sec. 27, 63-10.

994. Fine red syenite, broken in every direction, from the point between the two bays, N. W. ¼ of sec. 26, 63-10.

995. Hornblendic gneiss, from the second rapids, N. part of sec. 8, 63-10.

996. Igneous rock with a twisted and lenticular gneissic structure, from the hill-range just north of the foot of the portage, S. W. ¼ sec. 21, 63-10.

997. Chloritic syenite like 993, from north side of river near the rapids, N. part of sec. 29, 63-10.

998. Same as 997, obtained about half way up to Garden lake, in the rapids.

999. Same as 997, still further up the rapids, near the shore of Garden lake.

1000. Magnetic quartz schist, from the upper end of the rapids.

1001. Iron ore from Harvey's test-pits, S. E. ¼ of sec. 27, 63-12.

1002. Fine-grained gray siliceous felsitic rock, south shore of Long lake, sec. 28, 63-12.

1003. Slaty or schistose graywacke, half way from the lake shore to Patterson's trenches, sec. 28, 63-12.

1004. Confused sericitic schist, fissile lenticularly, bluff, centre of sec. 19, 63-11.

1005. From the same bluff but overlying 1004, resembling the rock of Kawasachong falls.

1006. Hardened sericitic schist, near contact with dike, N. E. ¼ of sec. 19, 63-11.

1007. Granular quartz with disseminated pyrite, got in contact with 1006.

1008. Obtained two feet from the dike above mentioned, on the south side.

1009. Sample of the dike rock.

1010. Represents the contact of 1008 and 1009.

1011. Essentially the Kawasachong falls rock, at various places between the lake shore and the hill in S. E. ¼ of sec. 19, 63-11.

1012. Black, banded, magnetic quartz schist, from boulders top of hill, S. E. ¼ of sec. 19, 63-11.

1013. Chalcedonic granular quartz, from veins in quartz schist, top of hill, S. E. ¼ of sec. 19, 63-11.

1014. Greenish-gray rock, apparently a modified graywacke, just south of line between secs. 19 and 30, west of trail, 63-11.

1015. Fine brecciated graywacke, rough in general outward aspect, N. E. ¼ of sec. 30, 63-11.

1016. Jasper hematite, centre of sec. 30, 63-11.

1017. Green schist with crystals of white triclinic feldspar and some granular quartz. N. W ¼ of sec. 28, 63-11.

1018. Similar schist on the same exposed surface, but without feldspar.

1019. Similar schist, less schistose. Same exposed surface.

1020. Similar rock, hardly schistose. Same exposed surface.

1021. Similar rock, but evidently changed from an igneous rock. Same exposed surface.

1022. Changed doleryte. Same exposed surface.

1023. Firm massive rock from midst of schists above mentioned, preserving in some places the original structure.

1024. Somewhat schistose magnetic iron ore, from Julian Bausman's, S. W. ¼ of sec. 23, 63-11.

1025. Magnetic iron ore, same locality, brought by Mr. Byrne.

1025 A. Poroditic and apparently overlying 1025, sec. 21, 63-11.

1026. Tremolitic schist, from the island crossed by the section line between 11 and 12, 64-11.

1027. Syenite, from an island in the lake, in sec. 1, 64-11, cut by an apparent dike of mica-schist.

1028. Micaceous rock, containing a thin (syenite?) vein or dike. Same locality. From the left of the contact.

1029. Less micaceous rock, obtained about a foot from the left of the last.

1030. Specimen obtained about three feet further from the left of the contact.

1031. Specimen obtained about 15 feet from the contact.

1032. Fine-grained, red-weathering syenite, gray within, often gneissic and jointed, sec. 23, 65-10.

1033. Micaceous (quartzose?) gneiss, from bands cutting the rock represented by sample 1032.

1034. Coarse vein rock containing the same minerals as 1032 in larger crystals, sec. 23, 65-10.

1035. Fine-grained, dark-gray rock, in some places apparently schistose, east end of portage from Ensign to Illusion lake, sec. 13, 64-8.

1036. Fine-grained (arenaceous?) rock, similar to 1035, Illusion lake, sec. 13, 64-8.

1037. "Muscovado" gabbro, finely granular, gray or yellowish, east side of Illusion lake, sec. 13, 64-8.

1038. Coarse gabbro, from the shore further south, sec. 13, 64-8. Shown on a small island.

1039. Biotitic gneiss, showing a contorted structure, first island south of last, sec. 13, 64-8.

1040. Ferriferous, olivinitic gabbro, little west of meander corner of secs. 28 and 29, N. E. ¼ of sec. 29, 64-7.

1041. Ferriferous gabbro, old mining place on Frazer lake, near the section line between 23 and 24, 64-7.

1042. Gneissic, biotitic gabbro, sometimes apparently quartzose, from the lake in the river, sec. 11, 64-7.

1043. Greenish amphibolitic rock, like that of the ridge south of S. E. part of Kekekabic lake.

1044. Gneissic (syenitic?) rock, south shore of the little gulf at the S. E. side of Kekekabic lake, sec. 11, 64-7.

1045. Thin-bedded gneissic (syenitic?) rock similar to 1044, but weathering reddish, south shore of Kekekabic lake, near the meander corner of sec. line bet. secs. 2 and 3, 64-7.

1046. Purplish-red, syenitic (?) sub-crystalline rock, from a small island near centre of sec. 3, 64-7.

1047. Fine-grained gabbro-like rock, much like 1035, inclosing 1048; S. W. corner Kekekabic lake, S. W. ¼ of sec. 3, 64-7.

1048. Rock composed of rounded and sub-angular masses apparently shading into 1047; S. W. ¼ of sec. 3, 64-7.

1049. Biotite gabbro, somewhat pebbly, bluff 6 feet above the lake, E. side of sec. 4, 64-7.

1050. From the same bluff, near the top.

1051. Orthoclase gabbro, west shore of lake, sec. 3, 64-7.

1052. Red rock, same as 1046, from near contact with 1051, on the point, at W. ½ of sec. 3, 64-7.

1053. Black petrosiliceous rock, distinctly bedded, sometimes slaty, sometimes black slate, N. W. ¼ of sec. 3, 64-7.

1054. Scales showing weathered surface of 1053.

1055. Lenticularly and coarsely schistose greenish schist, N. W. extension of 1049 and 1050, N. W. end of bay projecting northward into sec. 34, 65-7.

1056. Quartz and pinkish orthoclase, from seams in the schist 1055.

1057. Variety of 1055, non-schistose, near the meander corner between secs 35 and 36, 65-7.

1058. Two samples, one conglomeritic and the other a

hard coarse-jointed sometimes schistose rock; from the hill in N. W. ¼ of sec. 36, 65-7.

1059. Another phase of the same rock, non-schistose and coarse-jointed, N. E. ¼ sec. 36, 65-7.

1060. Gneissic mica-schist, apparently an extension of 1055, N. W. ¼ sec. 31, 65-6.

1061. Porphyry, from the east end of the narrows, N. W. ¼ sec. 31, 65-6.

1061 A. Green pebbles from 1061, same locality.

1061 B. Weathered surface of the porphyry, showing free quartz, ditto.

1062. Porphyritic conglomerate, near the narrows in lake No. 6, sec. 28, 65-6.

1062 A. Scale of 1062 coated with twinned crystals of feldspar.

1063. Conglomeritic quartzyte, often like graywacke in aspect, N. W. ¼ of sec. 27, 65-6. N. W. shore of the long bay from Ogishke Muncie lake.

1064. Conglomerate representing the general character of the rock about the bay last mentioned.

1065. Porphyritic conglomerate, from same locality.

1066. Gray quartzyte, sometimes pebbly, generally with no signs of bedding; narrows of bay, N. W. ¼ of sec. 27, 65-6.

1067. Schistose, almost fissile conglomerate, E. side of second narrows of Ogishke Muncie lake, N. W. ¼ of sec. 24, 65-6.

1068. Doleryte, from the hill a little north of the second narrows, east side, sec. 24, 65-6.

1069. Irony conglomerate, hill just northwest of the last, sec. 24, 65-6.

1070. Pebbly schistose conglomerate, from the rapids of the stream connecting Muncie and Town Line lakes, sec. 13, 65-4.

1071. Porphyritic greenish rock, the crystals being of a pyroxenic mineral apparently, northward projecting point, S. shore Frog-rock lake, sec. 18, 65-5.

1072. Green doleryte, from the east end of Frog-rock lake, sec. 17, 65-5.

1073. Coarse-jointed massive rock, apparently igneous, mouth of Ogishke Muncie creek, sec. 26, 65-6.

1074. Irregular stratum of 1073 holding fragments of fissile closely jointed baked slate, sec. 26, 65-6.

1075. Specimen showing the junction of 1073 and 1074 with a blending of characters, sec. 26, 65-6.

1076. Tough massive or coarse-jointed greenstone, from hills in southern part of sec. 35, 65-6.

1077. Pebbly greenstone graduating into 1076.

1078. Coarse-jointed massive rock like 1073 but porphyritic, sec. 35, 65-6.

1079. Matrix of the Ogishke conglomerate, one-third mile from the shore north of Campers' island, southern portion of sec. 23, 65-6.

1079 A. Pebbles from the same.

1080. Porphyritic conglomerate, N. E. corner of S. E. ¼ of sec. 22, 65-6.

1081. Siliceous black slate, N. E. ¼ of sec. 22, 65-6.

1082. Same as 1081 but thick-bedded and arenaceous, sometimes greenish, 80 rods N. W. of last, sec. 22, 65-6.

1083. Green-black so-called slate, resembling diabase, intersecting 1082, from hill, same locality.

1084. Fragmental rock from the dark-green beds represented by 1082, sec. 22, 65-6.

1085. Conglomerate from west side of Little Reynard lake, near the water, sec. 26, 65-6.

1086. Altered black slate, almost igneous-massive in appearance; N. W. side of Fox lake, S. E. ¼ sec. 26, 65-6.

1087. Cherty breccia from the beds shown on the portage between Fox and Agamok lakes, sec. 36, 65-6.

1088. Quartzyte slate, basaltic in aspect, N. shore of Gabimichigama lake, S. W. ¼ sec 29, 65-5.

1089. Hardened, fragmental siliceous rock in heavy layers, Gabimichigama lake, north side of long point, S. W. ¼ of sec. 32, 65-5.

1090. Siliceous biotitic gneiss, sometimes chrysolitic, from south shore of above point, sec. 32, 65-5.

1090 A. Fragment, apparently, of a boulder in 1090, same locality as last.

1091. Biotitic gneiss, without bedding, N. W. portion of S. W. ¼ sec. 32, 65-5.

1092. Stratified biotitic gneiss, showing sedimentary banding, N. W. corner S. W. ¼ of sec. 32, 65-5.

1093. Greenish, nearly homogeneous basaltiform rock, from the point in Kekekabic lake, S. E. side of sec. 29, 65-6.

1094. Porphyritic rock, representing an altered conglomerate, point corners of secs. 29. 30, 31 and 32, 65-6.

1095. Banded graywacke and slate, Mallmann's peak, S. E. ¼ sec. 30, 65-6.

1096. Rock of a dike making a couple of islands in Kekekabic lake, south of Mallmann's peak, N. W. ¼ sec. 31, 65-6.

1097. Chloritic schist with contorted sedimentary structure, shore of Kekekabic lake, S. E. ¼ sec. 30, 65-6.

1098. Conglomeritic chlorite schist, N. W. ¼ of sec. 31, 65-6; phase of 1060.

1099. Homogeneously micaceous rock sometimes gneissic, and conglomeritic variety of same; portage trail from Kekekabic lake northward, sec. 34, 65-7.

1100. Reddish syenite, with lenticularly schistose jointage, most westerly island in Kekekabic lake, sec. 3, 64-7.

1101. Greenish syenite, north side of same island, slightly further west, sec. 3, 64-7.

1102. Greenish syenite identical with 1101, west end of Animikie island, sec. 3, 64-7.

1103. Two samples from N. W. corner Animikie island, showing variations in the metamorphic change; sec. 3, 64-7.

1104. Diabasic rock, east end of same island, sec. 3, 64-7.

1105.–1106. Two samples of porphyritic rock from the little island N. E. of Animikie island, obtained a short distance from each other, on the north side, and showing many important features; sec. 2, 64-7.

1107. Light-weathering black or purplish flint, from the graywacke slates, north of the portage landing on Knife lake, W. side of sec. 27, 65-7.

1108. Mica-schist with bands and veins of syenite, west end of the portage, sec. 6, 64-10.

1109. Sericitic or felsytic schist, at the portage from Newton lake to Fall lake, N. W. ¼ sec. 3, 63-11.

SPECIMENS COLLECTED BY DR. WADSWORTH.

1110. Granite, from the island in White Iron lake, lying in sec. 33, 63-11 and sec. 5, 62-11.

1111.–1115. Schist of several kinds, some of it quartzose, some hornblendic and some micaceous or ferruginous, from the foot of White Iron lake near the northern end.

1116. Granite, same as that of the island (1110), obtained some distance from its contact with the schist, east shore of White Iron lake.

1117.
1118.
1119.
1120.
1121.
1122. Junction specimens of the granite and schist, all, with the exception of 1122, taken from a point part way up the cliff, north end of White Iron lake.

1123.
1124. Portions of the above schist more indurated and altered by contact with the granite, from a point lower down on the cliff.

1125. Portion of same schist cut by two granitic veins; near the lower contact (1123).

1126. Portion of the edge of the granite at the contact, filled with fragments of schist.

1127? Specimen of contorted schist containing magnetite.

1128. Gabbro, cut by intrusive granite, E. shore of White Iron lake.

1129. Intrusive granite as above.

1130.
1131. Specimens showing contact of a dike of the above granite, with the gabbro through which it is intruded.

1132. Black hornblendic gneiss, south of the meander line between secs. 6 and 7, 62-11.

1133. Micro-granite, from dikes cutting granite; meander line between secs. 6 and 7, 62-11.

1134. Micaceous gabbro, cut by veins of granite, from the lake shore in sec. 12, 62-12.

1135. Dark hornblendic rock, from small dikes cutting the granite veins above mentioned.

1136. Gabbro, containing considerable feldspar, from a point about half a mile west of the line between sec. 31, 62-11 and sec. 6, 61-11 in T. 61.

1137. Fine-grained gabbro, looking like diabase, from a point a short distance west of the meander stakes, between secs. 24 and 25, 61-12.

1138. Apparently an indurated schist or sandstone containing much magnetite, from a point just beyond the last.

1139. Granite, containing porphyritic crystals of feldspar, from a point just west of the meander corner between secs. 23 and 24, 61-12.

1140. Granite, fine-grained in texture like a micro-granite, about ⅛ of a mile west of the corner above given.

IV.

NOTES OF RECONNOISSANCES.—BY H. V. WINCHELL.

IV.

PARTIAL REPORT OF OBSERVATIONS MADE BY H. V. WINCHELL.

I. NOTES TAKEN AUGUST 26TH, 1886, ON A TRIP FROM FALL LAKE (T. 63, 11) TO LONG LAKE (T. 63, 12) AND ON THE HILLS NORTH OF LONG LAKE.

Long lake and Fall lake (Kawasachong lake) are connected by a stream of considerable size which falls 63 feet between the two lakes.

There are many little falls and rapids on the stream; but the only rock seen in the bed of the stream after passing the first rapids, is in loose pieces and boulders.

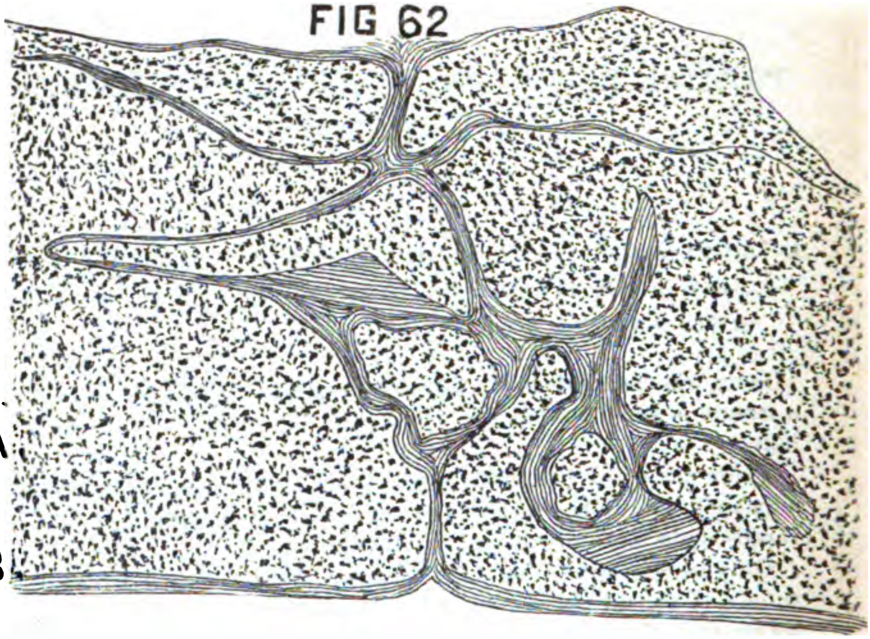
On the southeast side of the river near the line between ranges 11 and 12 in secs. 19 and 24, is a low range of rock hills. They are composed of light-colored hydro-mica-schist, finely siliceous and containing numerous small cubes of pyrite. These hills extend in an easterly direction along the south side of Fall lake.

Going up the river from Fall lake the first rapids encountered are over sericitic schist *in situ*. It is exceedingly schistose with the strike 60° E. of N., and with vertical strata. Ten rods further east the strike changes to N. 40° E. No more rock in place can be seen from the river on the way to Long lake.

Crossing to the north side of this lake we find precipitous hill-ranges running in a general direction N. 40° E. and increasing in hight as we cross them—going north, until the upper level is reached at 190 feet above the lake, as measured by the aneroid.

The hills in secs. 22 and 15 are made up chiefly of a fine-grained compact green rock. It is all so firm that there is no appearance of any stratification or schistose structure; but there are curved lines or threads of schistose rock running all through it. The rock in these veins sometimes appears like dioryte and sometimes like sericitic schist. There are crystals of hornblende in it that stand out on the weathered surface and give a darker and rougher appearance to the network of veins which is everywhere seen on the surface of the bare hills.

FIG 62



A

B

Fig. 62.—*Green schistose veinings in greenstone.*

Going northward through sec. 15, 63-12, the ranges of hills maintain about the same hight. They are precipitous and deep ravines separate them. The rock changes rapidly, becoming more massive and solid in structure as we go north. The hills nearest the lake are a sort of greenish hydro-mica [chloritic?] schist. The next ranges are harder and less changed by weathering, and are finely crystalline in structure like doleryte. The hills beyond these are coarser and look like fine dioryte and so on; the rock becoming coarser and more crystalline in structure toward the north.

Quartz veins are everywhere met with running in all directions and sometimes lying flat upon the surface. The general glaciation is N. 24° E. and the direction of the hill-ranges N. 40° E. The schistose rock seems to dip north and sometimes contains irregular-shaped fragments of the granular quartz such as were seen in the schists north of Tower.

One of the ranges of dioryte, as high above the lake as most of them, has had remarkable action exerted upon it by frost. Water seems to have penetrated the surface of a round knob of this rock and has split it apart to a depth of 20 or 30 feet, moving masses weighing thousands of tons, several feet asunder, and even lifting them up and turning them completely over. Water continually stands at the bottoms of the chasms.

The hills in this locality are nearly bare, have no soil on them, but few bushes and little moss. The opportunity for ascertaining the geology is excellent here, but it is rougher traveling than around the lake shores.

Portions of the rock in the first high range of hills north of the lake contain light greenish amygdules that stand out in little round globules on weathered surfaces.

The rock for the first three-quarters of a mile north of the lake, including the schist near the lake and the semi-crystalline rock further north, contains beds or veins of a very hard siliceous, partially metamorphosed rock which is probably petrosilex. This rock shows stratification both on the surface which weathers white and in the green interior.

The beds stand vertical and extend for an indefinite distance nearly east and west through the other rock. The general thickness is about six inches; but in some veins it is two or even three feet. An indistinct tendency to coarse crystallization was observed in these veins as if they were homogeneous enough to crystallize like a mineral and not to be made up of various different crystallized minerals like a rock. Some specimens were obtained showing this peculiarity. No. 29 (H).

The general impression obtained of this region is that it is on the boundary line between the purely schistose rocks on the south and the crystalline rocks on the north.

2. NOTES ON BAYS IV, V, III, AND II, BASSWOOD LAKE, MADE IN THE FIRST TEN DAYS OF SEPTEMBER, 1886.

Bay IV. Starting from the falls in sec 22, 64-11, and going up the left shore, the first observation made was on a small island in the N. W. ¼ of sec. 22. The rock here is a mixture of chlorite (?) and feldspar. The green mineral looks more like hornblende in fresh breaks; but the general appearance is that of chlorite. This rock seems to be massive and unstratified.

Near the south quarter-post of sec. 15, 64-11, is a bold bluff of greenish schist 25 feet above the water. The rock is composed of fine mica (partly hydrous), feldspar. and some chlorite or hornblende. It is very schistose; strike is N. 40° E., dip is S. W., at an angle of 85°. White feldspar stands out on the surface. In some places the rock is semi-crystalline and resembles dioryte, No. 30 (H). A quarter of a mile further northeast is a high bluff of micaceous chloritic schist. The hills rise 50-75 feet above the lake. Dip is 65° to the S. W. Eighty rods further on is a greenish, micaceous hornblendic schist containing a little feldspar. The rock changes rapidly in the direction of the strike and becomes less schistose. See Nos. 31 (H) 31 A (H) and 31 B (H.)

The schist contains disseminated nodules and lumps of iron ore schist.

Going northeast across the strike the rock becomes less schistose and contains gradually more feldspar and a green mineral, probably epidote. It finally passes into a rock composed almost entirely of feldspar and this green mineral. The other ingredients are a little mica and hornblende. It is very noticeable that as the schist changes into a more massive rock and the schistose structure disappears, a "stratification" is shown by a regular arrangement of the minerals in bands or layers having the same direction as the strike of the schist. No. 32 (H) shows this arrangement of the minerals. A little further along the rock is more coarsely crystalline and more largely feldspathic, also containing irregular-shaped patches of dioryte. See No. 33 (H).

The long point in the S. E. ¼ sec. 11, same township, is composed of layers of schist and dike-like beds running in a direction W. 10° S. Some of the beds of schist are very micaceous with muscovite and some are very siliceous. There are other variations in composition making the rock a queer mixture taken altogether. The dikes are diabasic and are well defined. They

cut the beds of schist very little, if at all. The dip of the schist is 80° to S. W.

A little further around the point the strike changes to west. Glaciation is N. 22° E.

The point in the N. W. ¼ of S. E. ¼ sec. 11, is composed of fine-grained mica-schist, dipping at an angle of 65° to the S. W.

On the point in the W. ½ of sec. 11 we find for the first time syenite mixing with the mica-schist. It very rapidly interbeds with it until the beds alternate with a thickness of from half an inch to three or four inches. Just before coming to this mixture of syenite and schist, were passed a few feet of greenish looking rock somewhat felsitic. See No. 34 (H). The strike of these beds is W. 24° S. See Fig. 63 for illustration of this place.

FIG 63

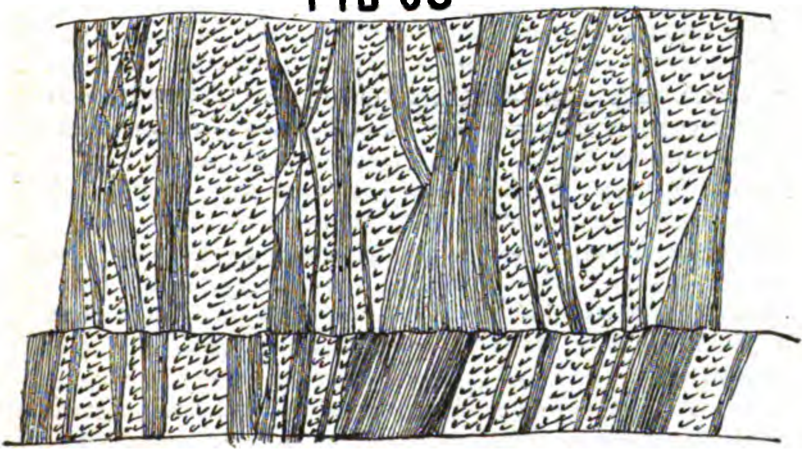


Fig. 63.—*Fault cutting interbedded syenite and schist.*

In the N. E. ¼ of sec. 11 is a bed of pinkish gneiss dipping S. at an angle of only about 15°. It is ten rods across and at the E. side of it is a coarse-grained syenite-gneiss standing nearly vertical. See Nos. 36 (H) and 37 (H). Some of the beds are hornblendic and some are almost wholly feldspar and quartz. This nearly flat-bedded syenite-gneiss continues for a quarter of a mile or more and there are frequent places where the jointage structure gives it the appearance of being in vertical beds.

Beds of syenite gneiss continue around the west shore of this bay for some distance; sometimes the gneiss contains small scales of biotite. In the S. E. ¼ of S. E. ¼ of sec. 2, 64-11, it is cut by beds

of pink syenite running E and W. There is the same apparent low angled dip, but the dike-like beds stand nearly vertical. It is noticeable that each bed seems to be much more massive on the E. or S. side than on the upper or N. W. side where it has a gneissoid structure. A few rods further on there is a bold bluff of pink gneiss, 15 feet high, very gneissic and standing apparently on edge, with the strike nearly N. and S.

The point in the S. E. ¼ of sec. 2 is composed, on the west side, of syenite. This gradually changes to a greenish siliceo-feldspathic rock like felsyte; and this grades into mica-schist. It does not remain long in that condition but passes back into a reddish-green rock that looks like syenite on the surface; but which seems to be only a mixture of syenite and schist. Strike is N. 70° E. See Nos. 38 (H), 38 A (H) and 38 B (H). A little further east the bluffs of syenite are higher and more quartzose. They contain also hornblende schist running in direction 10° S. of E. through the rock. These beds of hornblende schist vary in thickness from an inch to four or five feet.

Micaceous syenite-gneiss is found in N. W. ¼ of sec. 6, 64-10. Beds of hornblende schist are inclosed in this gneiss. The hornblende, however, often changes to mica and much quartz is present. On a small island near the shore at the N. W. corner of 64-10 is a display of perfectly interstratified schist and gneiss. The beds run N. 70° E. dip *north* 65° and alternate between hornblende-schist containing mica and syenitic gneiss with a little mica. It is one of the finest exposures to be seen in this region.

Bay V. The point in the S. ½ of sec. 36, 65-11, is a high bluff of syenite-gneiss containing beds of hornblende-schist. The general strike is N. 75° E. This bluff is rounded and bare and almost 50 feet high.

In the centre of sec. 2, 64-11, the syenite-gneiss again seems to dip north at an angle of 15° or 20°. It is thick-bedded and immense quantities are to be seen on all sides.

In the S. W. ¼ of sec. 2, 64-11, syenite-gneiss occurs interstratified with thin beds of mica and hornblende schists. The dip is N. 15° or 20°. There is a very large exposure at this place. The beds are cut by dikes or beds of syenite. See No. 45 (H). The rock in the N. E. ¼ sec. 10, 64-11, is gneiss, containing mica-schist interbedded with it; both being cut by syenite beds. It is coarsely crystalline in spots, the feldspar crystal being over half an inch long.

On the north side of the west end of the bay in sec. 8, 64-11, is a mixed exposure of syenitic gneiss and hornblendic schist. Beds or dikes of syenite run in all directions through and across the schist, inclosing and cutting it into all manner of shapes. Dip is N. 15°. See Nos. 47 (H), 48 (H). In the N. W. ¼ sec. 9, 64-11, there is a high ridge of syenite or dioryte interbedded with hornblende schist. It rises fifty feet above the lake and where it comes out to the lake shore it forms a huge bluff, the dip being north at angles varying from 15° to 60°. Strike is N. 60° E. Near the intersection of the shore line with the east line of sec. 4, 64-11, the syenite again crops out. Here there are thick beds of granite or gneiss and thin beds of mica-schist. The beds stand nearly vertical but have a slight inclination to the north. Strike is N. 70° E. See No. 49 (H). All the way across the east end of the long point in the N. ½ of sec. 3, 64-11, is a fine display of mica-schist and gneiss, interstratified in thin beds and dipping north 60°. General strike is N. 74° E. Nos. 50 (H) and 51 (H) are samples of this rock. Interstratified gneiss and mica-schist are again seen on the line between secs. 35 and 36, 65-11. They dip north 60° and the strike is N. 70° E. It is noticeable that the mica is coarser near the contact with gneiss than in the beds of mica-schist.

The long point in the N. E. ¼ of sec. 36, 65-11, is a high bluff of interbedded gneiss and mica-schist. It rises 50 feet above the lake. Dip is N. 70°. Strike is N. 70°. E.

BASSWOOD LAKE.

Bay III. Gneiss containing some hornblende is found on a low point in the N. E. ¼ of sec. 3, 64-10. It is thin bedded, 13 beds in a thickness of two feet being counted in one spot. It seems to dip south at a low angle. There are dikes cutting the beds in various directions. These dikes are very siliceous, being composed almost wholly of quartz and feldspar with a little mica. The quartz seems to be granular and not massive. See Nos. 52 (H) and 53 (H). A few rods further on there is some schist interbedded with the gneiss. In some places this schist is mostly hornblendic; in others quite micaceous.

Near the line between secs. 3 and 4, 64-10, is a bluff of dioryte (?). It rises ten or twelve feet above the water and shows no signs of gneissoid structure. The hornblende crystals are sometimes over an inch long. No. 34 (H).

This dioryte continues for several rods along the shore to the west. It suddenly comes into contact with gneiss and mica schist. The direction of the line of contact is E. 2° S. Crossing this bed of mica-schist we come to another bed of dioryte, then to a bed of mica-schist or hornblende-schist again and so on until it seems as if they were interbedded; though the dioryte appears to lie upon the other rocks a little as though it had flowed over them. The schists stand on edge (?) and run in the direction of the contact with the dioryte. There are also dikes of gneiss cutting the dioryte. Nos. 55 (H) and 56 (H). Near the west line of sec. 4, 64-10, is a ridge of syenitic gneiss which grades by imperceptible changes into schist. Dip is N. 60. Strike is N. 50° E.

The micaceous, hornblendic schist is somewhat siliceous and probably contains some feldspar. Gradually, in the space of a few inches along the strike, it acquires more and more quartz and feldspar until it becomes reddish syenite gneiss. Thus we have mica and hornblende schists changing to gneiss and syenite-gneiss, not only by being more and more finely interbedded, but also by a mixture of the minerals of which each rock is composed. Nos. 57 (H), 57 A (H), 57 B (H), 57 C (H) and 57 D (H), illustrate this transition.

On ahe west side of the portage in sec. 5, 64-10, is found mica-schist with considerable feldspar and quartz; also a porphyritic syenite-gneiss containing sometimes much mica. The feldspar crystals are white and stand out on weathered surfaces. Dip S. 85°.

Near the west line of sec. 5, 64-10, is a bed of rock resembling dioryte but containing biotite. It is coarsely crystalline and seems to dip south and under the syenite a little further west. See No. 59 (H).

There is a low outcrop of rock resembling diabase, very siliceous, in the S. E. ¼ of sec. 6, 64-10. It has no distinct bedding or schistose structure. Glaciation is N. 22° E. The point in the S. W. ¼ of sec. 5, same township, is made up of very fine mica-schist. It is in long smooth beds dipping south 80° or 85°. The strike is N. 60° E. This schist would make fine scythe stones. Only one bed of gneiss was seen on this point; it was a foot thick and about six feet long in the direction of the strike of the schist. It was completly inclosed by the schist and was very micaceous itself.

In the S. E. ¼ of the N. W. ¼ of sec. 16, 64-10, is mica-schist

in uneven wavy beds, dipping north at angles varying from 20° to 50°. Strike is E. 20° S. The schist seems to be an intermediate stage between gneiss and schist. Feldspar crystals stand out on weathered surfaces and give a whitish appearance to the rock. This schist is ferruginous and disturbs the compass. A little further up on the knoll the dip is south and the strike is E. 60° S. So this point is probably not as indicative of a general northern dip to the rocks of this locality.

3. PSEUDO-MESSER LAKE.

The bluffs around the west end of this lake are quite precipitous and heavily wooded. The rocks are quite different from those of the Basswood lake region; being apparently of the same character as the Vermilion lake rocks.

The general condition of the rock is an argillitic slate or schist varying to a siliceous graywacke that resembles diabase. Dip is south at a high angle and general trend is N. 70° E. There is much pyrite in small cubes, which have a greenish color scattered through the slate. There also appears a white mineral in many places in cracks and seams; it is perhaps dolomite. A small island in a bay at the south side of the lake presents some interesting features. The rock of which it is composed varies from a fine, homogeneous slate to a solid, coarsely granular rock with a basaltic structure and every appearance of trap. We see here also a grayish quartz-porphyry containing nodules of black jasper. This becomes finer and finer until it grades into a light greenish aphanyte. The rock on this island resembles very much that on the island at the mouth of Stuntz bay, Vermilion lake. There is a similar high range of hills just south of it too that suggests the iron range at Tower.

Knife lake. The hills at the west end of the lake are from 20 feet to 60 feet high, covered with small poplar, birch and cedar trees; while here and there are a few large pines, which having escaped the fires are left standing. The rock is very fine-grained siliceous slate, bluish-gray to greenish-black.

It is very finely banded in some places and sedimentary structure is very evident. In spots it becomes coarser and contains rounded nodules of vitreous quartz. It stands nearly on edge, dipping south 85° or 88°. The strike is quite uniformly N. 70° E. The slate is found coarse-grained on the east side of the bay in the S. W. ¼ of sec. 1, 65-7.

On a point near the west line of sec. 28, the slate has considerable quartz and pyrite in it.

In the N. E. ¼ of N. E. ¼ of sec. 27, 65-7, is a fine exposure of this flinty slate. The structure of the rock is not amorphous here, but passes into the greenish rock called porodyte seen at Stuntz bay, Vermilion lake.

The rocks and water look very much alike in this and adjoining lakes. Both are clear and have a greenish tint of cleanliness and purity that is refreshing to the eye.

The schistose structure and the bands of sedimentation when visible do not always coincide, sometimes varying one way and sometimes the other. On the point in the S. W. ¼ of sec. 23, 65-7, is a fine exhibition of the banded sedimentary structure. The bands run very nearly straight and uninterrupted across the surface of this knoll for several rods. Strike is N. 72° E. The beds vary in hardness and in color; but they all weather white on the surface. Dip is south 75°.

The rock composing the high bluff in the N. W. ¼ of the S. W. ¼ of sec. 24, 65-7, is very hard and tough with a basaltic structure. It is semi-crystalline, and of a grayish-green color.

In the S. E. ¼ of the same section is a knoll where the rock changes from the flinty slate to a fine conglomerate containing jasper and vitreous quartz, and further to a coarse conglomerate containing pebbles an inch long. This change occurs both in crossing the beds and in following the strike. Strike is E. 48° S. Glaciation is N. 30° E. See Nos. 71 (H), 71 A (H), 71 B (H). In the S. E. ¼ of sec. 19, 65-6, is a ridge of porodyte or felsyte. It is a greenish-gray rock, with green veins running through the white-weathered surface. There is a remarkable change in the strike of the rocks through here, as is indicated by the direction of the coast line. Strike is N. 40° S. There is a coarse schistose structure trending N. 50° E. Perhaps the high ridge of rock just south of this has something to do with it.

5. OGISHKE MUNCIE LAKE.

Going south from the lake through secs. 26 and 35, the first rock passed over is conglomerate, comparatively even bedded and undisturbed. Then the bedding begins to be broken and the strike and dip change very noticeably. Sometimes the strike and schistose structure are both N. 50° E., and dip south; sometimes the bedding trends from N. W. to S. E., the

schistose structure is N. E. and S. W., and the dip is west. The pebbles too become smaller and the rock is more metamorphosed. Frequently it is porodyte and just as often it is the fine siliceous slate, such as was seen at Knife lake. As soon as the higher hills in sec. 35 are reached this is all changed. No strike or dip or other evidences of sedimentary structure can be seen. It is a massive crystalline rock rising 350 feet above the lake. See. No. 73 (H).

The point crossed by the south line of sec. 23, 65-6, is composed of the stratified quartzyte and conglomerate formation. The beds are parallel and distinct. Dip is south 85°. Strike is N. 60° E. Some of the beds are not very siliceous, but appear to be argillyte; while others are coarse and semi-crystalline and contain small pebbles of quartz and jasper.

In the S. E. ¼ of the S. E. ¼ of sec. 23, 65-6, the rock is greenish and massive with basaltic structure and the general appearance of an igneous rock. It sometimes assumes a reddish or pinkish tinge and looks almost like syenite. Further up the hill, however, in the same hard massive rock are discovered boulders. Of course they are considerably changed from their original condition; but there they are, some as large as six inches in diameter. No. 74 (H) is a sample of this rock.

6. LIST OF SPECIMENS, COLLECTED BY H. V. WINCHELL, DURING THE SUMMER OF 1886.

No. 1 (H). From the point in S. E. ¼ sec. 20, 62-15. A compact semi-metamorphosed rock containing rounded grains of quartz scattered all through it.

No. 2 (H). From the island in the mouth of Stuntz bay, sec. 21, 62-15. A gray felsyte with an indistinct schistose structure and also a basaltic appearance.

No. 2 A (H). Pebbles of a soft greenish rock, perhaps a fine-grained sericite schist, which were contained in No. 2 (H).

No. 2 B (H). From Ely island, S. E. ¼ sec. 17, 62-15. Pebbles of quartzyte, jasper, etc., from the felsitic conglomerate No. 2 (H).

No. 3 (H). Ely island, N. E. ¼ sec. 15, 62-15. A sericitic schist, varying in coarseness from a rock like No. 1 (H) to slate. It seems to grade into the felsitic conglomerate.

No. 4 (H). From the island crossed by the line between secs. 15 and 16, 62-16. Gray sericitic schist; hard, tough, compact and contains pyrite.

No. 5 (H). From the N. W. corner of sec. 17, 62-16. A green homogeneous schist, moderately firm and compact. Has basaltic structure in places.

No. 6 (H). North side of the bay in the S. E. ¼ sec. 7, 62-16. Massive syenite, grayish red to greenish. In bold crags 15 feet above the lake.

No. 7 (H). From a point in S. E. ¼ sec. 8, 62-16. A fine-grained, evenly-bedded siliceous schist. Would make good whetstones.

No. 8 (H). Same locality as last. It is a fine conglomerate(?). The pebbles are feldspathic and quartzose. Color varies from reddish to greenish. The matrix is like sericitic schist.

No. 9 (H). From N. E. ¼ sec. 9, 62-16. Samples from a dike-like bed which appears to cut the sericitic schist, and even seems in one place to have thrown it over from a vertical to a horizontal position; but in another place has an indistinct structure of sedimentaton.

No. 10 (H). West side of point in sec. 5, 62-16. From dikes of rock similar to No. 2 (H), which cut the sericitic schist or stand in beds unconformable with it. Does not contain pebbles as did No. 2 (H).

No. 11 (H). S. E. ¼ sec. 5, 62-16. A tough, grayish-green rock, containing mica and pyrite with quartz-veins. Has also nodules of syenite dispersed through it. Dike runs parallel with the bedding which is east and west; but the schistose structure is N. 20° E.

No. 12 (H). Coarse chloritic mica-schist from the S. side of an island in S. W. ¼ sec. 32, 63-16. It apparently grades into the sericitic schist.

No. 12 A (H). Dike-rock running east and west through No. 12 (H). It is porphyritic and the crystals of feldspar are harder than the matrix or ground-mass of the rock which is schistose. This rock resembles No. 8 (H), the so-called conglomerate. The dikes are six inches to two feet in thickness.

No. 12 B (H). Green schist lying on the north side of the dikes which furnished No. 12 A (H).

No. 13 (H). Fine-grained characteristic mica-schist from S. W. ¼ sec. 31, 63-16. This schist rises 30-40 feet above the lake in hills running N. 26° E. It contains numerous short veins of quartz.

No. 13 A (H) is pink syenite from dikes or beds in the mica-schist last mentioned. The dikes have a general east and west

direction, and vary in color from white to very dark and from two to eight feet in thickness.

No. 13 B (H) is from green trap dikes which run in all directions through the schist at this same place.

No. 13 C (H). A firm, non-schistose grade of No. 13 B (H). It is fine, compact, and of a grayish-green color. It contains the constituents of granite.

No. 14 (H). A heavy, fine-grained schist from S. W. ¼ sec. 6, 62-16. Contains some feldspar, much pyrite and little mica. Some strata seen to contain hematite.

No. 15 (H). Near the township line in N. W. ¼ sec. 7, 62-16. A heavy, massive, greenish-black dioryte (?); probably a dike. It forms an outcrop of 100 feet or more.

No. 16 (H). On the south side of this dike is a bed of porphyritic syenite. It rises in a bold knob 20 feet above the lake. Perfect crystals of feldspar, half an inch long, stand out all over the weathered surface of the rock and can be picked out with little trouble.

No. 17 (H). A greenish siliceous schist with faint bedding and basaltic structure from the point in the S. W. ¼ of S. E. ¼ sec. 1, 62-17, much like No. 14 (H).

No. 18 (H). From a small island in S. E. ¼ of N. E. ¼ sec. 11, 62-17. A hard greenish rock with no apparent bedding; but with a schistose structure running E. 40° S.

No. 19 (H). From a ridge of hard pinkish-green dioryte, or syenite, rising up out of the mica-schist in sec. 3, 62-17. It is very tough and massive and makes hills 90 feet above the lake. There are alternate beds, or ridges, of this rock and mica-schist along the shore in sec. 3 for a considerable distance. The general direction is the same as the schistose structure of the schist, viz.: N. 60° E.

No. 19 A (H). From dike of red syenite cutting the last in N. E. ¼ of N. E. ¼ sec. 3, 62-17. Direction of dike is E. and W.

No. 20 (H). A pink rock that appears to be almost wholly feldspar. It is partially decomposed and has a schistose structure, and grades by imperceptible degrees into the green hydromica schist. It is found on the south side of a small island in the centre of sec. 2, 62-17.

Long lake.

No. 21 (H). Hydromica schist from the first rapids encoun-

tered going up the river from Fall lake to Long lake. Sec. 24. 63-12. It is very schistose and is a fine, soft rock; like slate.

No. 22 (H). Greenish, schistose rock from the top of Sunset peak, half a mile north of the east end of Long lake, 62-12. There are three specimens representing the different aspects of the rock.

No. 23 (H). Specimens of the rock from the veins or twisted beds which are found running all through the hill-tops in the same peak.

Nos. 24 (H), 25 (H), 26 (H), 27 (H) and 28 (H) are specimens taken in that order from the different hill-ranges crossed in going north through sec. 15, 63-12. They exhibit the tendency of the rock to become more crystalline in structure.

No. 29 (H). Four specimens of petrosilex from the beds in the rock within half a mile north of the east end of Long lake. They seem to be imperfect crytals.

Basswood lake.

No. 30 (H). Near the S. quarter-post of sec. 15, 64-11, from a bluff of greenish, micaceous schist varying in hardness, some being almost like fine dioryte.

Nos. 31 (H), 31 A (H) and 31 B (H) are from the N. E. ¼ of sec. 15, 64-11, showing changes from a fine micaceous schist to a hard compact rock with no apparent structure of any kind. The schist contains porphyritic nodules of feldspar and occasionally of quartz.

No. 32. (H). Same locality as last, a little further to the N. E. It is a hard condition of the schist showing the schistose nature by the arrangement of the constituent minerals in regular lines or bands.

No. 33 (H). A little further to the N. E. More coarsely crystalline rock and more feldspathic, containing irregular patches of dioryte.

No. 34 (H). A greenish felsitic rock, met with just before coming to the interstratified mica-schist and syenite in the middle of sec. 11, 64-11.

No. 35 (H). A piece of the syenite which is interstratified with mica-schist in the same locality as last.

No. 36 (H). Pink gneiss from N. E. ¼ of sec. 11, 64-11. It dips south at an angle of 15°. It is 10 rods across.

No. 37 (H) is coarse syenite-gneiss, standing nearly vertical at the east end of last.

Nos. 38 (H), 38 A (H), and 38 B (H) are intermediate grades of rock between syenite and mica-schist. From the point in S. E. ¼ of sec. 2, 64-11.

No. 39 (H). Sample of the felsitic rock on the N. E. side of same point.

No. 40 (H) is a specimen of the hornblende-schist which runs through the syenite in vertical beds of a few inches to five feet in thickness; a little further east than the last.

No. 41 (H). Sample of schist inclosed in gneiss with the hornblende of the schist changing to mica. N. W. ¼ sec. 6, 64-10.

No. 42 (H). Dark hornblendic gneiss from the same locality.

No. 43 (H). Gneiss that appears on the surface like a hard sandstone or stratified quartzyte. From N. W. corner 64-10.

No. 44 (H). Hornblendic gneiss from W. side of the point in S. ½ sec. 36, 65-11. Shows hornblende and mica in a state of confused mixture.

No. 45 (H). Samples of schist interstratified with gneiss from S. W. ¼ sec. 2, 64-11.

No. 46 (H). Coarse gneiss, from N. E. ¼ sec. 10, 64-11. It is interstratified with mica-schist and cut by syenite dikes.

No. 47 (H). Syenite-gneiss, very fine, containing much hornblende. N. E. ¼ sec. 8, 64-11.

No. 48 (H). Hornblende-schist, containing mica. From same locality.

No. 49. (H). Where the east line of sec. 4 enters the bay, is obtained a sample of mica and hornblende-schist inclosing a thin bed of granulyte.

No. 50 (H). Gneiss which is interstratified with mica-schist, on the north side of the point in sec. 3, 64-11.

No. 51 (H.) Sample of the mica-schist from the same place.

No. 52 (H). Gneiss; which is cut by dikes or beds of granulyte in the N. E. ¼ sec. 3, 64-10. Gneiss occurs in very thin beds.

No. 53 (H). Granulyte or dike rock which cuts the last.

No. 54 (H). Dioryte; one sample fine, two very coarse. From W. side sec. 3, 64-10.

No. 55 (H). Schist from same locality as last. This appears to be interstratified with last.

No. 56 (H). Is the gneiss that occurs, interbedded with the schist. Same place as last.

Nos. 57 (H), 57 A (H), 57 B (H), 57 C (H) and 57 D (H) show

53

a transition from schist to syenite-gneiss by a gradual change in the character of the minerals which compose the rocks.

No. 58 (H). Porphyritic syenite-gneiss. From W. side of the portage in sec. 5, 64-10.

No. 59 (H). Micaceous dioryte from the W. side of sec. 5, 64-10.

No. 60 (H). Siliceous green rock resembling diabase, S. E. ¼ sec. 6, 64-10.

No. 61 (H) is a coarser crystalline rock from the same place. It lies just north of No. 60 (H).

No. 62 (H). Mica-schist intermediate between schist and gneiss, with the mica and feldspar arranged in layers. S. E. ¼ of N. W. ¼ of sec. 16, 64-10.

No. 63 (H). From a locality in Canada on Pseudo-messer lake. One sample is an argillitic slate and one is a semi-crystalline, somewhat siliceous rock, containing much pyrite in cubes.

No. 64 (H). is a quartz porphyry containing granular nodules of glassy quartz and lumps or grains of an opaque white mineral.

Nos. 64 A (H), 64 B (H), 64 C (H), and 64 D (H) are finer and finer grades of the last number, becoming finally a light greenish rock, like felsyte. These specimens are from an island in a small bay on the south side of Pseudo-messer lake.

No. 65 (H) is a specimen showing the transition from the quartzyte to the stratified siliceous argillyte. From same place as last.

No. 66 (H). Argillaceous slate of a dark color, from the centre of sec. 31, 65-7, Knife lake.

No. 67 (H). Is an average specimen of the flinty slate from which the lake takes its name (Knife lake). It is hard, fine-grained, and of a bluish-black color.

No. 68 (H). A specimen of the flinty slate showing how white it becomes on weathered surfaces. From S. W. ¼ sec. 23, 65-7.

No. 69 (H). Grayish-green basaltic rock which forms the high bluff in N. W. ¼ of S. W. ¼ sec. 24, 65-7. Contains much marcasite (?) and is the "gold rock" which caused so much excitement in that region a few years ago.

No. 70 (H) is a semi-crystalline rock which seems to be composed of chlorite, sericite and vitreous quartz. It is from N.W. ¼ of S. E. ¼ sec. 24, 65-7.

Nos. 71 (H), 71 A (H), and 71 B (H) show the change from a

flinty slate to a conglomerate, containing pebbles an inch long. S. E. ¼ sec. 24, 65-7.

No. 72 (H). Finely crystalline greenstone containing vitreous quartz. From N. W. ¼ of S. E. ¼ sec. 20, 65-6.

Ogishke Muncie lake.

No. 73 (H). Gabbro (?). From sec. 35, 65-6, in hills 350 feet high. S. of the lake.

No. 74 (H). Greenstone resembling trap. S. E. ¼ of S. E. ¼ of sec. 23, 65-6, near the top of the hills south of Ogishke Muncie lake.

V.

CHEMISTRY.

REPORT OF PROF. J. A. DODGE

V.

CHEMISTRY.

REPORT OF PROF. J. A. DODGE.

MINNEAPOLIS, May 16, 1887.

Prof. N. H. Winchell,

DEAR SIR: I hereby report to you the results of the chemical analyses made at this laboratory, for the State Geological Survey, since my report of May 27, 1886.

	Chemical series No. 179.		No. 180.		No. 181.		No. 182.	
Silica, SiO_2	50.86	per cent.	61.09	per cent.	51.82	per cent.	50.41	per cent.
Alumina, Al_2O_3	15.72	"	15.34	"	13.19	"	13.40	"
Sesquioxide of iron, Fe_2O_3	9.77	"	5.74	"	4.88	"	9.96	"
Protoxide of iron, FeO	2.48	"	3.69	"	6.45	"	9.94	"
Lime, CaO	10.52	"	3.10	"	8.38	"	7.84	"
Magnesia, MgO	3.55	"	1.33	"	5.44	"	1.73	"
Soda, Na_2O	3.89	"	3.41	"	3.21	"	2.47	"
Potash, K_2O	.90	"	3.65	"	2.14	"	1.79	"
Water, H_2O	2.53	"	1.80	"	2.29	"	.87	"
	100.22		99.15		97.80		98.41	

	Chem. series No. 183.		No. 184.		No. 185.	
Silica, SiO_2	49.65	per cent.	57.09	per cent.	53.43	per cent.
Alumina, Al_2O_3	16.36	"	17.28	"	13.81	"
Sesquioxide of iron, Fe_2O_3	4.39	"	4.88	"	5.08	"
Protoxide of iron, FeO	7.19	"	3.42	"	9.86	"
Lime, CaO	9.18	"	5.29	"	8.25	"
Magnesia, MgO	8.00	"	3.55	"	4.64	"
Soda, Na_2O	2.49	"	3.97	"	2.51	"
Potash, K_2O	1.17	"	3.54	"	1.12	"
Water, H_2O	2.39	"	.84	"	.27	"
	100.82		99.86		98.97	

	Chem. series No. 186.		No. 187.	
Silica, SiO_2	61.19	per cent.	58.77	per cent.
Alumina, Al_2O_3	15.22	"	13.12	"
Sesquioxide of iron, Fe_2O_3	3.20	"	5.45	"
Protoxide of iron, FeO	3.55	"	6.87	"
Lime, CaO	7.94	"	5.99	"
Magnesia, MgO	2.38	"	4.93	"
Soda, Na_2O	3.17	"	1.94	"
Potash, K_2O	2.62	"	2.83	"
Water, H_2O	.40	"	.45	"
	99.67		100.35	

The nine analyses above reported are analyses of crystalline rocks. The analyses were made during the past winter by J. A. Dodge and C. F. Sidener.

	Chemical series No. 188.		No. 189.	
Silica, SiO_2	65.17	per cent.	20.90	per cent.
Magnetic oxide of iron, Fe_3O_4	30.06	"	70.29	"
Protoxide of iron, FeO	2.23	"	2.01	"
Dioxide of titanium, TiO_2	2.48	"	2.23	"
Lime, CaO	traces		traces	
Magnesia, MgO	traces		2.63	"
Alumina, Al_2O_3	traces		1.75	"
	99.94		99.81	
Total iron, Fe	23.50	"	52.46	"

	Chemical series No. 190.		No. 191.	
Metallic iron	54.1	per cent.	51.30	per cent.
Titanium	none		none	
Chromium	none		none	

The four analyses, 188, 189, 190, 191, are analyses of magnetic iron ores. They were made in April of this year by J. A. Dodge and C. F. Sidener.

	Chem. series No. 192.		No. 193.	
Silica, SiO_2	53.25	per cent.	42.10	per cent.
Alumina, Al_2O_3	21.13	"	15.12	"
Sesquioxide of iron, Fe_2O_3	6.88	"	5.14	"
Carbonate of lime, $CaCo_3$	2.42	"	17.80	"
Carbonate of magnesia, $MgCo_3$	3.78	"	5.53	"
Soda and potash	traces		traces	
Water, H_2O	11.59	"	14.00	"
	99.05		99.69	

The two analyses, 192 and 193, are analyses of clays, by C. F. Sidener.

Yours very respectfully,

JAMES A. DODGE, *Prof. Chemistry.*

VI.

RAILROAD ELEVATIONS.—BY. N. H. WINCHELL.

VI.

RAILROAD ELEVATIONS.

PREPARED BY N. H. WINCHELL.

ST. PAUL, MINNEAPOLIS & MANITOBA RAILWAY.

	Miles from St. Paul.	Feet above the Sea.
Junction of Osseo Branch	12.05	822.40
Parker	17.16	884
Shingle creek, bottom 868, water 871		882
Osseo	23.76	892
Elm creek, bottom 875, water 878		885
Rush creek, bottom 902, water 906		926
Maple Grove station		947
Hassan	34.03	977
Crow river, bottom 856, water 859	35.26	876
St. Michaels	38.17	963
Monticello	47.43	937
Silver Creek station	55.63	1117
Silver creek, 1¼ miles north of station, bottom 965, water 967		976
Clear Water river, bottom 935, water 942, high water of 1867, 957		964
Rice creek, bottom 954, water 956		966
Clear Water station	62.24	964
Plum creek, bottom 954, water 957		967
St Augusta creek, bottom 936, water 959		987
St Augusta station	69.23	1018
Three Mile creek (S. of St. Cloud), bottom 992, water 995		1016
St. Cloud depot	75.43	1041
Bridge over Mississippi river, water 976		1036.3
Sauk river, bottom 1035, water 1038		1053
St. Joseph	82.12	1092
Collegeville	84.91	1099
Avon	90.30	1135
Albany	96.35	1206
Getchell's creek, water 1197		1208
Freeport	102.62	1246
Sauk river, bottom 1174, water 1178		1190
Melrose	108.85	1247
Sauk river, bottom 1214, water 1228		1242
Sauk Centre	116.82	1260
West Union	124.65	1342

ST. PAUL, MINNEAPOLIS & MANITOBA RAILWAY.—*Continued.*

	Miles from St. Paul.	Feet above the Sea.
Osakis	130.50	1348
Nelson	136.16	1374
Alexandria	141.58	1396
Garfield	148.37	1422
Brandon	154.05	1393
Aldrich lake, bottom 1361		1374
Evansville	159.21	1294
Interlaken	166.07	1237
Pelican lake, water 1222		1234
Ashby	168.32	1300
Dalton	175.84	1366
Pomme de Terre river, water 1233		1268
Parkdale station	179.25	1283
Sand lake, water 1194	184.43	1195
Fergus Falls (depot)	186.51	1196
Carlisle	195.26	1239
Rothsay	203.85	1203
Lawndale	209.57	1088
Barnesville	218.43	1021
Downer	225.79	982.4
Glyndon	235.31	945.5
Averill	241.81	919.40
Felton	248.44	917.40
Borup	254.99	913.40
Ada	265.22	908.40
Lockhart	275.00	896.40
Rolette	276.72	895.40
Beltrami	282.06	904.40
Etna		905.40
Russia	287.99	895.00
Kittson	292.35	888.40
Carman	298.00	885.40
Crookston (river 842)	299.32	868.40
Shirley	305.82	905.40
Euclid	313.23	895
Angus	321.12	875
Warren	329.80	858
Argyle	339.60	850.40
Stephen, bottom of Tamarack river, 816	348.11	832.40
Donaldson	356.59	831.40
Kennedy	361.46	830.40
Hallock	370.50	820
Northcote	376.18	807.40
Humboldt	383.00	797
St. Vincent	390.25	792.50
International boundary	391.07	795

Brown's Valley Branch.

	Miles from St. Paul.	Feet above the Sea.
Graceville		1106.8

ST. PAUL, MINNEAPOLIS & MANITOBA RAILWAY.—*Continued.*

St. Cloud & Hinckley Branch.

	Miles from St. Paul.	Feet above the Sea.
Oak Park	....	1118.64
Foley	....	1122
Downer	....	968.4

From Fergus Falls to Pelican Rapids.

	Miles from St. Paul.	Feet above the Sea.
*Junction	....	1174
Elizabeth	198.96	1256
Ehrhardt	202.42	1301
Pelican river, 2 miles S. from Pelican Rapids. [Bottom 1297]	....	1304
Pelican Rapids	208.40	1319

From Shirley to St. Hilaire.

	Miles from St. Paul.	Feet above the Sea.
Shirley	305.82	905.40
Ives, gravel ridge, top of ridge 1002	314.43	998.70
St. Hilaire	327.28	1090.70
Black river, 3.4 miles N. E. of Ives, water 981	....	1002
Gravel ridge, ½ mile E. of Black river	....	1007

WISCONSIN CENTRAL RAILROAD.

By F. W. Fratt.

	Miles from St. Croix.	Natural Surface.	Grade Elevations.
St. Croix river, bottom 705, low water 715, high water	.0	728	794
Highway	1.2	858	860

*This branch starts from the Northern Pacific Railway, half a mile east of the Manitoba freight yard, and runs level northeasterly till it crosses the Red river.

WISCONSIN CENTRAL RAILROAD.—*Continued.*

	Miles from St. Croix.	Natural Surface.	Grade Elevation.
Arcola	2.4	920	917
Government road	3	898	901
Carnelian lake, water	4.6	912	920
Highway, Sec. 6, 30-20 W	7.25	991	992
Highway, Sec. 12, 30-21 W	9.25	951	955
Crossing St. P. & D. R. R	11	1035	1017
Summit, Sec. 28, 30-21 W	13.3	1085	1074
Four Lakes station	14.6	1015	1005
Long lake, water	15.2	975	990
Castle	16.9	1024	1025
Junction St. P. & D. R. R	20.4	....	938

NORTHERN PACIFIC RAILROAD.

	Miles from St. Paul.	Feet above the Sea.
St. Paul	0	701
Minneapolis	11	832
Fridley	18	848
Coon Creek	25	860
Anoka	29	883
Itaska	36	891
Elk River	41	901
Bailey's	45	918
Big Lake	50	940
Becker	57	976
Clear Lake	64	997
Haven	71	1011
E. St. Cloud	76	1030
Sauk Rapids	77	1004
Watab	83	1053
Rice's	90	1059
Royalton	97	1080
Gregory	103	1095
Little Falls	107	1115
Belle Prairie	112	1130
Topeka	116	1144
Fort Ripley	121	1158
Albion	126	1173
Crow Wing	130	1186
Brainerd	138	1208
Mississippi river, low water	....	1152
Gull river	146	1189
Sylvan Lake	148	1203
Pillager	151	1200
Bath	156	1212
Motley	160	1223
Staples Mills	168	1250
Dower Lake	170	1290

NORTHERN PACIFIC RAILROAD.—*Continued.*

	Miles from St. Paul.	Feet above the Sea.
Aldrich	174	1327
Verndale	178	1347
Wadena	185	1349
Wadena Junction	187	1350
Bluffton	190	1310
Amboy	193	1376
New York Mills	197	1409
Richmond	203	1394
Perham	209	1367
Luce	214	1370
Frazee	220	1384
Johnson	225	1393
Detroit	230	1362
Audubon	237	1308
Lake Park	242	1334
Hillsdale	248	1399
Hawley	254	1150
Muskoda	258	1090
Glyndon	267	924
Tenny	269	920
Moorhead	275	903
Red river, low water	....	867

Little Falls & Dakota Division.

	Miles from Little Falls.	Feet above the Sea.
Little Falls	0	1115
Mississippi river	....	1081
La Fond	7	1184
Swan river, low water	....	1152
Swanville	11	1171
Manley Creek	....	1171
Gray Eagle	26	1223
Summit, 2½ miles east of Gray Eagle	....	1223
Birch Lake station	29	1227
Spaulding	31	1292
Summit, 1½ miles W. of Spaulding	....	1338
Sauk river, low water	....	1219
Sauk Centre	37	1242
St. P., M. & M. grade	....	1253.5
Westport	48	1332
Villard	53	1358
Summit, 1 mile E. of Glenwood	....	1413
Glenwood	60	1402
Trappers' run, near Pelican lake	....	1144
Minnewaska lake	....	1135

Little Falls & Dakota Division.—Continued.

	Miles from Little Falls.	Feet above the Sea.
Starbuck	69	1160
Little Chippewa river, low water		1160
Summit, 2 miles W. of Little Chippewa		1193
Big Chippewa river, low water		1120
Cyrus	79	1150
Summit, 2½ miles W. of Cyrus		1200
Pomme de Terre river		1087
Morris depot		1129

Fergus Falls & Black Hills Division.

	Miles from Wadena.	Feet above the sea.
Wadena	0	1349
Wadena Junction	1	1350
Deer Creek	10	1394
Parkton	14	1394
Henning	18	1437
Vining	24	1389
Clitheral	29	1346
Battle Lake	33	1354
Maplewood	39	1360
Underwood	42	1343
Red river, first crossing 1231, second crossing		1174
Fergus Falls, low water of river 1150	53	1183
Pelican river, low water		1124
French	59	1085
Ames	60	1063
Everdell	69	992
Breckenridge	77	960
Bois des Sioux, low water		946
Wahpeton	78	963

Wisconsin Division.

	Miles from L. Superior.	Feet above the Sea.
Chequamegon bay, lake Superior	0	602
Ashland	2	669
Omaha Junction	6	642
Moquah		849
Iron		1036
Iron river		1094

Wisconsin Division — Continued.

	Miles from L. Superior.	Feet above the Sea.
Muskeg	....	1100
Topside	....	1151
Brule	....	990
Blackberry	....	1134
Maple Ridge	....	1093
Midland	....	939
Cutter	....	732
Superior	64	608
Bay of Superior, water	....	602
Walbridge	76	842
Carlton	79	938
N. P. Junction	87.5	1080

Duluth and Brainerd Line.

	Miles from Duluth.	Feet above the Sea.
Lake Superior	....	602
Duluth	0	608
N. P. Junction	23	1080
Pine Grove	28	1235
Norman	33	1315
Corona	39	1301
Cromwell	45	1304
Wright	51	1307
Tamarack	57	1269
McGregor	66	1226
Kimberly	75	1235
Aitken	87	1207
Cedar Lake	92	1220
Deerwood	97	1275
Jonesville	108	1236
Brainerd	114	1208

ST. PAUL & NORTHERN PACIFIC RAILROAD.

	Miles from St. Paul.	Feet above the Sea.
Small iron bridge, near Fourth street, St. Paul	....	716.86
East Seventh street	....	726.64
Trout brook, water 737.64	1	747.64
Westminster street	....	752.64
Crossing Manitoba R. R	....	757.64
Crossing St. P., M. & O. Ry	....	762.14

St. Paul & Northern Pacific Railroad — Continued.

	Miles from St. Paul.	Feet above the Sea.
Trout brook, crossing second time, water 765.64	1.4	768.64
Mississippi street	1.6	773.64
Trout brook, water 790.64, public road, 792.64	2.1	798.64
Cortland street (cut 30 feet)	2.4	817.64
Rice street	....	835.64
Crossing of creek	3.5	856.64
Western avenue	3.6	858.64
Dale street	4.3	889.64
Como avenue	4.6	910.64
Como road	4.7	912.14
Section line between 27 and 26	5.2	925.64
Summit on the Como property	5.6	977.84
Snelling avenue (section line 28 and 27)	6.2	920.64
Cut of 20 feet	6.4	912.64
Track to Fair grounds	6.5	909.64
Westwood avenue (fill 13 feet)	6.8	899.64
Section line between 29 and 28, on Rich avenue	7.3	898.64
Raymond avenue	7.6	902.64
Bayless avenue	7.7	903.64
Transfer track St. P., M. & M	7.9	902.24
County line crossing (in St. Anthony Park)	8.4	885.64
Mary street (edge of bluffs)	8.6	856.64
Chicago, Milwaukee & St. Paul Railway crossing	9.2	827.64
University avenue, Minneapolis	9.4	827.64
Cut along Arlington street descends from 827.64 to	....	815.64
Church street	....	822.64
State street	....	818.64
Pleasant street	9.6	816.14
The ground on which the University stands at the place of this cut	....	848
Level of bridge	....	815.64
Top of the limestone ledge at the bridge, east side 789.64 west side*	....	784.64
Top of sand rock, east side 759.64, west side	....	759.64
Bottom of Mississippi river	10	716.64
Low water in rapids	....	720.64
Nineteenth avenue S	....	812.64
Bluff street	....	811.64
Cedar avenue	10.4	810.64
Tenth avenue S., natural surface	....	815.64
Depot, St. P., M. & M. Ry	11.4	813.14
Hennepin avenue at St. P., M. & M	11.4	831.64
Grade at First avenue N	....	817.64
Street at First avenue N	....	836.64
First street N. (street level 841.64), grade	....	824.64
Fourth avenue N. (street at 4th. avenue N. 846.64), grade	11.9	825.64

* The apparent difference of level of the limerock on the east and west sides of the river is probably due to a difference in the amount of erosion and not to a dip in the formation.

Line B (Through Elwelltown).

	Miles from St. Paul.	Feet above the Sea.
Bayless avenue in St. Anthony Park		903.64
Last cut in the bluffs (24 feet)		890.64
Como avenue	9.3	858.64
Division street	9.7	856.64
St. Paul & Duluth Ry		850.64
Fillmore street	10.7	849.64
Harrison street		848.64
Monroe street	11.3	841.64
Twenty-third avenue N. E.	11.6	849.64
Twenty-fourth avenue N. E.	11.8	850.64
Bridge over Mississippi river (Twenty-fourth ave.)	13.2	825.64
High water, 803.64; low water		794.64

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Line between Minneapolis and Cologne.

	Miles from Minneapolis	Feet above the Sea.
Depot, Minneapolis	0	825
Short Line Junction	1.8	843.66
Cedar avenue (grade of street, 866.66.)	2.3	859.66
Chicago avenue	3	864.66
Portland avenue	3.3	866.16
Nicollet avenue	3.8	876.36
Lyndale avenue	4.3	878.66
Hennepin avenue	4.8	879.66
Long station	5.3	860.91
Cut of 18 feet	5.8	876.66
Bass lake (water 879.66)	6.9	885.66
Summit	8	918.66
Marsh (marsh level 890.66)	8.4	900.66
Hopkins station (C., M. &. St. P.)	8.8	912.66
Crossing, spur track of M. & St. L.	8.9	911.66
Minnehaha creek	9	911.66
Hopkins station (M. & St. L.)	10.1	922.66
Davis creek	11.1	900.66
Shady Oak lake (water 906.66)	12	910.66
Foot of Mud lake (water 904.66)	12.6	909.66
Crossing M. & St. L. Ry	13	922.66
Island lake (water 893.66)	14.5	898.66
Purgatory creek (bottom 839.66)	15.3	901.66
Duck lake (water 911.66)	15.7	921.66
Chanhassen	18.2	967.16
Marsh	20.1	914.36
Lake Hazeltine (water 918.66)	21.6	923.66
Hazeltine	21.8	929.66
Chaska creek (water 896.66)	22.5	938.66
Summit	23.5	962.66

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.—*Continued.*

	Miles from Minneapolis	Feet above the Sea.
Fill (natural surface 922.66)	25.2	934.66
Augusta	27	979.66
Lake avenue	28.4	946.66
Carver creek (water 912.66)	29.8	922.66
Cologne	30.5	943.66

Elevations on the Stillwater Branch.

	Miles from Stillwater.	Feet above the Sea.
Stillwater (on trestle work)		696.64
Stillwater, extreme high water of lake		695.14
Stillwater, water July 10, 1881		684.14
Baytown (or S. Stillwater)	3.3	696.64
Lakeland	8.2	744.64
Afton	11.1	697.14
Trout brook (water, lake level)	14.4	701.64
Straight Cooley	16.9	702.64
Point Douglas	22.7	711.64
Junction with River Division	25.6	696.64

Short Line from St. Paul to Minneapolis.

	Miles from St. Paul.	Feet above the Sea.
Chestnut street, St. Paul	.8	710.41
Fort street		789
Grace street	2.8	829.66
St. Clair street	3.5	876.66
Big cut, natural surface 929.66, centre	3.8	901.66
Under Summit avenue	4	908.66
Summit (Snelling avenue)	4.8	938.66
Merriam Park	5.8	909.66
Ford's Nursery	6.6	874.66
Hennepin county line	7	849.66
Top of rock bluff, east bank	7.3	800.66
Mississippi river, high water 725.86, low water		710.66
Bridge over the river	7.3	844.66
Minnehaha avenue	8.8	843.66
Short Line Junction	9	843.66
Depot (Washington avenue)	10.8	825

CHICAGO, BURLINGTON & NORTHERN RAILROAD.

	Miles from St. Paul.	Feet above the Sea.
Pig's Eye bridge	2	707.5
Newport	7.5	749.8
Quarry	14.8	699
Altenberg Cooley	17	695.5
Hastings, bluff crossing (Pt. Douglas)	19	693.5
Point Douglas, highway crossing	21	710
St. Croix river, bottom 652	21.8	702.4

ST. PAUL & DULUTH RAILROAD.

Branch from Wyoming to Taylor's Falls.

	Miles from St. Paul.	Feet above the Sea.
Wyoming	29.8	896
Junction near Wyoming, about 1-6 of a mile south from the depot	29.65	898
Summit, natural surface 909, grade	30.4	903
Summit, natural surface and grade	33.6	922
Chisago City	36.0	917
Trestle bridge over Chisago lake, water 896, grade	38.4	928
Lindstrom	38.6	932
Summit, natural surface and grade	39.1	937
Chisago lake, water 896, grade	40.2	901
Centre City	40.3	901
Bridge at Centre City, bottom 861.5, grade	....	901.5
Summit, natural surface 950, grade	42.6	946
Siding	43.8	937
Franconia	45.8	915
Lawrence creek, bottom 857, water 861, grade	46.3	901
First sandrock cut	47.8	855
Trap-rock cut, top of rock 823, grade	48.9	797
Taylor's Falls, passenger depot	49.1	791
Taylor's Falls, freight depot and yard	49.9	750

Branch from Rush City to Grantsburgh, Wis.

	Miles from St. Paul.	Feet above the Sea.
Junction near Rush City, about 1-5 of a mile south from the depot	53.6	916
Rush creek, water 841, grade	56.3	849
St. Croix river, water 775, grade	58.6	795
Summit, natural surface and grade	69.1	921
Grantsburgh	70.2	895

Knife Falls Branch.

	Miles from St. Paul.	Feet above the Sea.
Northern Pacific Junction	....	1082
Knife Falls station	....	1179
Knife Falls, high water (St. Louis river)	....	1171.55
Knife Falls, low water (St. Louis river)	....	1166.55

From White Bear to Stillwater.

	Stations.	Feet above the Sea.
Junction near White Bear lake	0	938
White Bear lake, water 926	72	935
Dellwood	104	942
Mahtomedi, low point in grade	155	927
Summit of grade, cut 20 feet	340	984
Summit	410	919
Brown's creek, bottom 858	502	867
Brown's creek, bottom 837	530	853.5
Depot at Stillwater	617	723
Grade at the lake (Myrtle street)	650	686
St. Croix lake, at Stillwater	650	672.5

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.

Ed. Johnson, Chief Engineer.

Blue Earth Branch.

		Feet above the Sea.
Lake Crystal	....	1003.16
Garden City	....	966
Vernon Centre	....	1028
Amboy	....	1048
Winnebago City	....	1101
Crossing of the C., M. & St. P. Ry. at Winnebago	....	1109
Blue Earth City	....	1088
Elmore	....	1131

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.— *Continued.*

Eastern Division.

		Feet above the Sea.
St. Paul, east end of Union Depot sheds	....	708
Mississippi river	....	688
St. Paul Junction with St. P., M. & M. (near East St. Paul)	....	780
East St. Paul	....	827
Midvale	....	1012
Oakdale	....	984
Lake Elmo	....	938
Stillwater Junction	....	884
Lakeland Junction	....	811
River Falls Junction	....	702
St. Croix lake at Hudson	....	679
Hudson	....	723

Superior Junction to Duluth.

		Feet above the Sea.
Superior Junction	....	1091.50
Nunekagon river, water	....	1039
Lake Side	....	1110
Gordon (St. Croix river, 1017)	....	1033
White Birch	....	1135
Three miles N. of White Birch	....	1240
Hawthorne	....	1156
Douglas	....	963
Superior Short Line Junction	....	647
Superior Junction with N. P.	....	637
Superior, depot	....	645
West Superior	....	624
Rice's Point, Duluth	....	619.50
St. Louis bay, water	....	603.50

Western Division.

		Feet above the Sea.
St. Paul	....	708
Mississippi river, low water	....	688
Mendota, depot (C., M. & St. P. Ry.) 727	....	722
Nicols	....	722

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—*Continued.*

Western Division.—Continued.

		Feet above the Sea.
Hamilton		723
Barden		747
Shakopee depot		751
Shakopee, crossing (H. & D. Ry.) at grade		758.50
Merriam Junction, crossing (Minn. & St. L.) at grade		745
Jordan		758
St. Lawrence		754
Belle Plaine		733
Blakeley		737
E. Henderson		731
Le Sueur		751
Ottawa		799
St. Peter		757

Sioux Falls Branch.

		Feet above the Sea.
Sioux Falls Junction		1643
Rushmore		1675
Adrian		1558
Drake		1636
Warner		1482
Luverne, crossing at grade, B., C. R. & N		1457
Luverne, depot		1471
Luverne, junction with Rock River Branch		1471
Beaver creek		1463
Valley Springs		1411
Brandon		1336
Sioux Falls, crossing at grade C., M. & St. P., 1418		1414
Hartford		1580
Montrose		1480
Salem, depot		1537

Rock River Branch.

		Feet above the Sea.
Luverne		1471
Ash creek		1415
Rock Rapids		1464
Doon		1305

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—*Continued.*

Black Hills Branch.

		Feet above the Sea.
Heron Lake station	....	1425
Dundee	....	1453
Lime creek	....	1488.50
Avoca	....	1542
Slayton	....	1614.50
Hadley	....	1698.50
Lake Wilson	....	1665.50
Woodstock	....	1831.50
Pipestone, crossing at grade B., C. R. & N	....	1734.50
Pipestone depot	....	1729.50

MINNEAPOLIS & ST. LOUIS RAILWAY.

Pacific Division.

From the profiles by G. Ifflinger.

	Miles from Minneapolis	Feet above the Sea.
Hopkins	8.7	921
Minnetonka Mills	11.7	936
Tamarack marsh, bottom 880	14.5	909
Hotel St. Louis	15.8	943
Carson's bay, water 928, 18 feet deep	16	933
Solberg point, on bridge	17.9	938
Excelsior	18.9	947
Centennial House	25	936
Waconia	31.5	986
Marsh, surface 978	34–34.7	981
Young America	39.1	993
H. D. crossing	40.3	976
Hamburg	43.8	1000
Carver and Sibley county line	45	995
Green Isle	48.1	1001
Arlington	54.3	995
Branch of Rush river, outlet of Felton lake, water 981.5	58.3	996
Gaylord	62.3	993
Winthrop	69.3	1015.5
Rush river, bottom 1022.5	71.8	1030
Gibbon	77.4	1046
Sibley and Renville county line	82.2	1046
Mud creek, bottom 1022	84.2	1038
Fairfax	86.9	1041.5

MINNEAPOLIS & ST. LOUIS RAILWAY.—*Continued.*

Pacific Division.—Continued.

	Miles from Minneapolis	Feet above the Sea.
Three Mile creek, bottom 1015	90.2	1024
Franklin	94.9	1005.2
Purgatory creek, bottom 966.5	95.4	997
Johnson's creek, bottom 941	95.8	983
Thompson's creek, bottom 871	96.5	938
Campbell's creek, bottom 868	97	913
Birch Cooley creek, bottom 827.5	98.7	837
Morton	100.4	841
Minnesota river, bottom 814	100.9	840
Bottomland of Minnesota river	101.4	827

CHICAGO & NORTHWESTERN RAILWAY.

E. Johnson, Chief Engineer.

		Feet above the Sea.
*Sleepy Eye station	....	1027
Junction one mile west	....	1008
Morgan	....	1043
Paxton	....	1032
Redwood Falls station	....	1026
The river, west of the station	....	946
This river elevation is above the rapids at the head of the falls.		

* Lake Michigan is given by the U. S. Lake Survey at 582, which makes Sleepy Eye 1027. Gannett gives for Sleepy Eye station (C. & N. W. Ry.) 1020, and for Sleepy Eye 1034. The latter Mr. Upham has used in final report, p. 565.

The figures given above by Mr. Johnson differ by 7 feet from the one and 5 feet from the other.

MINNEAPOLIS, LYNDALE & MINNETONKA RAILWAY.

From the profiles in the office of Geo. W. Cooley.

	Miles from Bridge Sqr.	Feet above the Sea.
First street, Bridge square	.00	837.5
Second street	....	838
Crossing of Washington avenue	....	842

MINNEAPOLIS, LYNDALE & MINNETONKA RAILWAY.— *Continued.*

	Miles from Bridge Sqr.	Feet above the Sea.
Crossing of Third street	....	840
Crossing of Fourth street	....	847
Crossing of Fifth street	....	850
Crossing of Sixth street	....	854.5
Crossing of Seventh street	....	852
Crossing of Eighth street	....	852
Crossing of Ninth street	.54	844.5
Crossing of Tenth street	....	850
Crossing of Eleventh street	....	850.5
Crossing of Twelfth street	....	854
Crossing of Thirteenth street and First avenue S	.86	852
Crossing of Thirteenth street and Nicollet avenue	....	847
Crossing of Grant street	1.02	841
Crossing of Fourteenth street	....	844
Crossing of Fifteenth street	....	849
Crossing of Sixteenth street	....	852
Crossing of Seventeenth street	....	854.5
Crossing of Eighteenth street	....	863.5
Crossing of Nineteenth street	....	867
Crossing of Franklin avenue (or Twentieth street)	1.52	878.5
Crossing of Twenty-second street	....	897
Crossing of Twenty-fourth street	....	895
Crossing of Twenty-fifth street	....	888
Crossing of Twenty-sixth street	....	874
Crossing of Twenty-seventh street	....	871
Crossing of Twenty-eighth street	2.26	872
Crossing of Twenty-ninth street	....	873
Crossing of H. & D. Ry	....	872.5
Crossing of Twenty-ninth and one-half street	....	872
Crossing of Lake street	....	871
Crossing of Thirty-first street	....	869
Crossing of Blaisdell avenue	....	870
Crossing of Lindley avenue	....	871
Crossing of Pleasant avenue	....	876
Crossing of Grand avenue	....	876
Crossing of Harriet avenue	....	877
Crossing of Rogler avenue	....	878
Crossing of Lyndale avenue	3.11	877
Crossing of Aldrich avenue	....	876.5
Crossing of Bryant avenue	....	876
Crossing of Colfax avenue	....	877
Crossing of Dupont avenue	....	878
Crossing of Emerson avenue	....	879
Crossing of Fremont avenue	....	880.5
Crossing of Girard avenue	....	881.5
Crossing of Hennepin avenue	3.61	883
Crossing of Humboldt avenue	....	881
Crossing of Irving avenue	....	882
Crossing of Knox avenue	....	883
Crossing of Thirty-second street	....	885
Crossing of Thirty-third street	....	883.5
Depot at Lake Calhoun	4.14	883.5
Depot at Lake Harriet	....	862
Crossing of the centre line of sec. 8	....	891
Crossing of the centre line of sec. 7	6.80	903

MINNEAPOLIS, LYNDALE & MINNETONKA RAILWAY.—*Continued.*

	Miles from Bridge Sqr.	Feet above the Sea.
Crossing of Minnehaha creek, water 886; bottom 860	7.44	871
Marsh, water, 867, bottom 853	7.54	871
Crossing of centre line, Sec. 19 (Mendelssohn), natural surface 933	9.44	920
Crossing of H. & D. Ry	10.14	898
Crossing of M. & St. L. Ry	10.54	901
Marsh, N. W. ¼ Sec. 25, water 885	10.74	889
Divide, N. E. ¼ Sec. 27	12.14	953
Depression, S. W. ¼ Sec. 27, near Glen lake	13.14	906
Marsh, near centre of Sec. 33, water 918	13.64	924
Divide	14.64	945
Purgatory creek, S. W. ¼ Sec. 29, water 860.5, bottom 858	15.44	897
Divide, natural surface 994	17.44	975
Marsh, part of Christmas lake, surface 915	18.44	990
Crossing of M. & St. L. at Excelsior	18.50	921.8
Junction of Hutchinson extension with the old motor line.	18.79	922
Excelsior depot	18.97	928
Excelsior depot of M. & St. L. Ry., same level as this road	19.54	931
Crossing of line, Secs. 32 and 33	21.79	965
Crossing Carver county line	22	968
Depression, near Lake Minnewashta	24	933
Crossing M. & St. Louis Ry., end of Schutz lake	24.09	959.5
Centennial lake, water 930	25.01	934.24
Summit, N. E. corner Sec. 4	27.22	977
Outlet of Parley lake, north side Sec. 5, water 910	28.79	928
Summit	30.09	959
Clearwater lake, Coney Is. Sta., water 946	31.05	953
S. W. ¼ Sec. 2	32.15	957
Crossing of line, Secs. 3 and 4	35.81	961
Crossing of Crane creek, centre of Sec. 2, bottom 913	37.85	938
Crossing of line, Sec. 4 and 5, T. 116, R. 116	40.19	971
Crossing Crane creek, W. ½ Sec. 6, water 934	42.24	943
Otter creek, E. ½ Sec. 1, bottom 938	42.85	947
Lester Prairie station	43.95	960
E. ½ Sec. 4, T. 116, R. 27 (Luth. church)	45.60	1007
Outlet of Mud lake	50.26	1024
Summit, E. ½ Sec. 4, T. 116, R. 28	51.47	1040
Crossing Bear creek, E. ½ Sec. 6, T. 116, R. 28, bottom 1009	53.36	1028
Summit, W. ½ Sec. 2, T. 116, R. 29	56.15	1053
Summit, W. ½ Sec. 4, natural surface 1062, highest point on the line	58.15	1053
Crossing Crow river, bottom 1006	59.75	1027
Hutchinson station, corner Washington and Adams streets	60.05	1023

DULUTH & IRON RANGE RAILROAD.

Natural Surface Levels.

	Miles from Duluth.	Feet above the Sea.	Grade Levels.
Water level Lake Superior		602	
Connection with St. Paul & Duluth R. R	.00	608	608

DULUTH & IRON RANGE RAILROAD.— *Continued.*

Natural Surface Levels.— Continued.

	Miles from Duluth.	Feet above the Sea.	Grade Levels.
Summit	.55	656	635
Chester creek, bottom	.81	602	632
Summit	1	627	632
Depression	1.33	612	633
Rock-cut, summit	1.90	664	657
Summit	2	658	670
Tischer creek, bottom	2.58	634	667
Summit	3	690	686
Summit, station "New London"	4	690	685
Summit, station "Lester Park"	5	655	650
Lester river, bottom	5.34	604	650
Summit	6.25	668	660
Summit	7.50	667	665
Summit, station "Clifton"	8	656	661
Summit	9.25	676	673
Talmage river, bottom	10.69	658	691
Summit	11	699	700
Summit	12	704	697
French river, bottom	12.10	677	697
Summit	12.20	710	697
Smith's creek, bottom	12.65	650	696
Summit	13	709	700
Summit	14.50	699	697
Big Sucker river, bottom	14.83	630	684
Summit	15	688	687
Little Sucker river, bottom	15.63	612	664
Summit, station "Lake View"	16	663	661
Stony Point	16.71	680	671
Rock	17	667	662
Rock	17.50	678	666
Summit	18	646	645
Knife river, bottom, station "Knife River"	18.70	602	620
Summit	19.25	644	641
Summit	20	666	657
Summit	21	653	651
Rock	21.65	683	675
Summit	22	701	693
Rock	22.21	707	697
Summit	23	723	716
Summit	23.50	734	732
Summit	24.50	768	767
Depression	25.51	677	696
Summit	25.75	688	687
Two Harbors, a junction	26.10	692	692
Two Harbors, depot, 2520ft. from junction	....	632	634
Summit	26.53	688	680
Summit	27.46	874	873
Summit	27.93	902	897
Summit	28.27	928	932
Summit	28.92	1032	1017
Summit	29.58	1060	1060

DULUTH & IRON RANGE RAILROAD. —*Continued.*

Natural Surface Levels.— Continued.

	Miles from Duluth.	Feet above the Sea.	Grade Levels.
Summit	30.36	1097	1099
Summit	31.45	1221	1213
Summit, station "Sibiwissa"	32	1236	1230
Summit	32.61	1302	1294
Summit	33.66	1395	1375
Summit	34.40	1440	1433
Summit	35.53	1522	1511
Summit	36.24	1597	1584
Summit	36.88	1659	1652
Summit	37.18	1722	1706
Summit, highest point, station "Gakadina"	38.84	1760	1734
Summit	39.20	1720	1712
Summit	40.23	1644	1642
Summit	40.46	1683	1653
Depression	41.33	1594	1602
Summit	41.67	1630	1616
Summit	42.36	1610	1608
Summit	43	1562	1564
Summit	43.80	1570	1545
Little Cloquet river, bottom	44.20	1498	1521
Summit	44.50	1534	1526
Summit	45.43	1492	1490
Cloquet river, bottom. station "Cloquet River"	46.22	1477	1490
Summit	47.55	1554	1545
Summit	48.67	1586	1570
Summit, Wissakode	49.46	1582	1578
Summit	50.38	1607	1596
Summit	51.44	1619	1617
Summit	52.67	1644	1615
Outlet Bassett lake, bottom	53.18	1570	1587
Summit	53.91	1640	1630
Summit Bassett lake	54.97	1661	1642
Whiteface river, bottom	55.41	1609	1635
Summit	55.84	1676	1655
Summit	56.84	1637	1638
Summit	57.22	1682	1672
Summit	57.75	1707	1693
Summit	58.55	1657	1657
Summit	59.86	1652	1648
Summit	60.68	1619	1614
Summit	61.53	1609	1607
St. Louis river, bottom, station St. Louis River	62.07	1594	1607
Summit	63.56	1609	1607
Summit	64.91	1574	1569
Summit	65.50	1546	1543
Summit	67	1524	1516
Partridge river, bottom	68.26	1499	1514
Summit	69.24	1504	1510
Beaver Dam creek, bottom, Okewanim	70.20	1481	1494
Summit	71.37	1519	1514
Summit	72.18	1543	1536
Summit	73.20	1514	1514

DULUTH & IRON RANGE RAILROAD.—*Continued.*

Natural Surface Levels.— Continued.

	Miles from Duluth.	Feet above the Sea.	Grade Level.
Mesaba creek, bottom	73.68	1479	1486
Summit	74.78	1564	1559
Mesaba Heights, station	75.32	1611	1604
Summit	76.30	1541	1538
Summit	77.41	1489	1487
Summit	78.62	1445	1440
Depression Embarrass river bottom	80.38	1421	1440
Summit	81.54	1454	1448
Summit	82.46	1484	1477
Summit	83.50	1489	1479
Summit	84.92	1507	1484
Summit	85.74	1452	1448
Summit	86.94	1479	1470
Summit	88.91	1453	1446
West Two Rivers, bottom	89.39	1414	1424
Summit	89.52	1442	1418
West Two Rivers, bottom	89.72	1401	1413
Summit	90.38	1449	1439
Summit	91.20	1414	1406
East Two Rivers, bottom	91.79	1374	1384
Summit	92.45	1389	1381
Summit	92.76	1407	1402
Summit	93	1419	1415
Breitung Mine station, Tower yard	93.97	1434	1424
Tower	95.75	....	....
Vermilion lake, water level	....	1357	....

DULUTH & MANITOBA RAILROAD.

[*Operated by the Northern Pacific Railroad Company.*]

From profiles in the office of J. B. Holmes, President, Minneapolis.

	Miles from Winnipeg Junction.	Feet above the Sea.
Winnipeg Junction, 227 miles from Duluth	.0	1181
Buffalo river, bed 1150, grade	0.5	1172
Summit, natural surface and grade	5.8	1253
Ulen	13	1154
South branch of Wild Rice river, bed 1113, grade	13.6	1135
Twin Valley	25.5	1093
Wild Rice river, bed about 985, grade	27.6	1010
Norman	33.8	1099
Sand Hill river, bed 1075, water, July, 1886. 1085; grade	44.5	1115

DULUTH & MANITOBA RAILROAD.—*Continued.*

	Miles from Winnipeg Junction.	Feet above the Sea.
Fertile	45.5	1140
Kittleson creek, bed 1094, grade	48.1	1124
Crossing Fosston branch of St. Paul, Minneapolis & Manitoba railway	57.1	1116
Tilden	57.3	1116
Badger creek, bed 1033, grade	64.9	1045
Junction of Red Lake Falls spur	68.7	1038
Red Lake Falls (on this spur)	69.3	1037
Red Lake river, bed 934, grade	70.6	966
Summit, cutting 9 feet, grade	73	1013
Black river, bed 941, grade	75.9	976
Crossing Saint Hilaire branch of St. P., M. & M. Ry	78.3	979
Crossing St. Vincent line of St. P., M. & M. Ry	86	903
Water-tank, grade	90	874
Junction of Keystone spur	93.3	857
Keystone (at end of this spur)	96.3	857
Grand Marais slough (former channel of Red Lake river), bed 813, grade	101.6	830
East Grand Forks	104.7	833
End of spur to river, East Grand Forks	105.1	809
Red river, bed 779, low and high water, 784-821	....	....

[This road was built in 1886. Above notes copied from profiles by Warren Upham, May 16,1887.]

VII.

MINNESOTA GEOGRAPHICAL NAMES DERIVED FROM THE CHIPPEWA LANGUAGE.

a lake or river will often be found condensed in a single word of its name. Names cling very tenaciously and survive the total sweeping away of the ancient inhabitants who named them; as is abundantly evidenced in our own country and in those beyond the sea, where the names of localities given by the original Irish race, for instance, remain, though another race totally different in blood, religion and language has come in and occupied their place.

In compiling the accompanying list of names, I have, besides the knowledge of them obtained by myself while journeying more or less for nearly 13 years past in nearly all parts of the Ojibways in Minnesota, called to my aid Indians and mixed bloods familiar with the different localities by having journeyed or lived there.

Thus from some I have obtained the rivers, etc., in Dakota bordering on Minnesota; from others those in the British Possessions; from others those connected with Otter Tail lake and river, etc., etc.

I have taken pains to be accurate, and to put down nothing doubtful; and if in any instance I have erred it has not been willfully.

In treating of the two principal rivers of Minnesota, the Mississippi and Red rivers, I have followed the plan of beginning at the source and tracing them along.

Many of the names are in localities yet unsettled by white men, but they will be settled one day, and in the near future, and then those names will be of interest. The English names I have taken from Warner and Foote's map of Minnesota published in 1881, as being the best to which I had access.

The list is not yet complete. There are many lakes between Red and Cass lakes, for instance, which I have not yet had opportunity to get, but names of which I hope to get when I go there, and send to the society. Since making the list I have learned of one slight correction; that the Indians call a part of the Mississippi above Cass lake by a different name, which name I hope to get and send the next time I visit Cass lake and talk with the Indians there.

It is hardly necessary to say that knowing the Indian language has alone enabled me to make this slight contribution.

Believe me, very respectfully yours,

J. A. GILFILLAN,
Missionary to the Ojibway Indians.

KEY TO THE ORTHOGRAPHY.

A, a, is pronounced as a in *what*.
E, e, " " e in *men*.
I, i, " " i in *pin* or *machine*.
O, o, " " o in *note*.
U, u, " " u in *full*.

The *consonants* are sounded as in English.

Diphthongs.

Ai is pronounced as the pronoun *I*.
Au " " ow in *now*, *vow*.
Ia or ia is pronounced as ya (a in *father*).
Ie or ie " " ye (a in *hate*).
Iw or iw " " *you*.
Uo or ua " " wa (a in *fall*, *what*).
Ue or ue " " *way*.
Ui or ui " " *we*.
Uo or uo " " *woe*.

1. The name by which the Ojibways or Chippewas call lake Superior is Kitchigumi, meaning great water.

2. Pigeon river is Omimi-zibi, Omimi meaning pigeon, and zibi — whenever it occurs — river. It can be written either zibi or sibi, but the former represents more accurately the sound.

3. The bay south of Pigeon river put down on the map as Waswaugoning bay is called by the Ojibways, *Wasswewini-wikwed*, making-a-light-by-torches bay, i. e. to catch fish by night.

4. Grand Portage bay is called Kitchi Onigum or great portage.

5. The river marked on the map as Maw-ske-qua-caw-maw is called Mesqua-tawangawi-zibi or Red Sand river; the Mesqua being "red," tawanga "sand," and the wi a connective.

6. Horse-shoe bay is Wiquedons. The Little bay, Wiquedonsing at or to the-little-bay.

7. Brule river is Wissakode-zibi or Half-burnt-wood river.

8. Devil-track river is Manido-bimadagakowini-zibi, meaning, the spirits or God walking-place-on-the ice river.

9. Bay of Grand Marias is Kitchi-bitobig, the great duplicate-water; a parallel or double body of water like a bayou.

10. Poplar river is Ga-manazadika-zibi, i. e. place-of-poplars-river.

11. Cross river is Tchibaiatigo-zibi, i. e. wood-of-the-soul-or spirit river; they calling the Cross, wood of the soul, or disembodied spirt. This river is so called from a priest who long ago crossed from the south shore of lake Superior in the night and in the morning set up a cross there. The grandson of the woman who was with him in the canoe is my informant.

12. Manitou river is the same as above, Manido-bimadagakowini-zibi, there being two rivers of that name on the north shore of lake Superior.

13. Beaver bay is Ga-gijikensikag. The-place-of-little-cedars.

14. Split-rock river is Giniuwabiko-zibi; the-war-eagle-iron-river.

15. Gooseberry river is Shabonimikani-zibi;Gooseberry-place-river, or the-place-of-gooseberries river.

16. Encampment island is called "Miniss" or the island, that being the only one all along the north shore nearly to Pigeon river.

17. The bay opposite is called Minissing-Wiqued or the bay-at-the-island, or island-bay.

18. Silver creek is Shonia-zibiwishe, Silver creek.

19. Stewart's river is Bitobigo-zibi, Parallel river, or Double river, no doubt from its flowing parallel to Silver creek.

20. Agate bay is Wasswewining, making-a-light-by-torches; i. e. to fish by night; ing is the termination at or to.

21. Knife river is Mokomani-zibi, Knife river.

22. Sucker river is Namebini zibi. Sucker river.

23. French river is Angwassago-zibi or Flood-wood river.

24. Lester river is Busabika-zibi. Rocky-cañon river, or the river-that-comes-through-a-worn-hollow-place-in the-rock.

25. Duluth is Onigumins, or the little portage, so called from their carrying their canoes over Minnesota point into the bay. Oniguminsing at or to Duluth.

Places on northern boundary going from lake Superior are as follows:

26. Moose lake, Mozo-sagaiigun. Sagaiigun, wherever it occurs, means lake and hereafter only the first syllable need be written, i. e., sag.

27. Pine lake, Shingwako-sag, Pine lake. Shingwak is a pine, o a connective vowel, sagaiigun lake.

28. Mountain lake, Gatchigudjiwegumag-sag. The lake-lying-close-by-the-mountain or Mountain lake.

29. Rove lake is Ga-wissakweagumag-sag. The lake-lying-in-the-burnt-wood-country.

30. Rose lake is Ga-bagwadjiskiwagag-sag, or the shallow-lake-with-mud-bottom.

31. Clearwater lake (near Rove lake) is Ga-wakomitigweiag-sag, or Clearwater lake.

32. Iron lake is Biwabiko-sag, Iron lake.

33. Gun-flint lake is Biwanago-sag, or Gun-flint lake.

34. Greenwood lake is Ushkakweagumag-sag, or Greenwood lake.

35. Saganaga lake is Ga-sasuganagag-sag, the lake surrounded by thick forests.

36. Bear-skin lake is Muko-waiani-sag, or Bear-skin lake.

37. Otter-track lake is Nigig-bimikawed-sag, the lake-where-the-otter-make-tracks. From four tracks of an otter on the rocks by the side of the lake, as if he had jumped four times there.

38. Knife lake is Mokomani-sag, Knife lake.

39. Cacacowabic lake is Kekekwabiko-sag, meaning hawk-iron-lake.

40. Bebiqwudjibiwudjissing-sag is the Ojibway name of Snow-bank lake. The word means the-snow-blown-up-in-heaps-lying-about-here-and-there-lake.

41. Basswood lake is Bassemenani-sag or Dried blue-berry lake.

42. Burnt-side lake is Ga-nubune-abikideagumag-sag. The lake-where-the-timber-has-been-burnt-off-on-one-side.

43. Long lake, Ga-shagawigumag-sag, long-narrow lake.

44. The large lake, about three miles northeast of Long lake, nameless on the map, is Ga-wassidjiwuno-sag,* or the lake-that-is-white-with-the-foam-of-the-rapids.

45. Birch lake is Ga-wigwassensikagumag-sag, Little Birch lake, or the-place-of-little-birches-lake.

46. Ka-wishiwi-river is correct; means The river-full-of-beaver's-houses; or according to some, musk-rats houses also.

47. Eagle's Nest lake, east of Vermilion lake, is properly Muko-minisiwi-sag; Bear-island lake.

48. Embarrass lake, St. Louis county is Gatitisawangidjiwung-sag. The-lake-with-the-sand-whirling-round-in-the-water-by-means of-the-current.

49. The nameless lake, north and a little east of Embarass, is Showiminabo-sag or Wine lake, literally Grape-liquid-lake.

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* Frank Blatchford, Chippewa interpreter at Ashland, Wis., writes this Gawasijiwang.—[N. H. W.]

50. Eshquaguma lake is Eshquegumag, Last-water-lake, or Last-lake.

51. St. Louis river is Kitchigumi-zibi, or lake Superior river.

52. The nameless lake on Partridge river is Bine-sag; Partridge lake.

53. Partridge river is Bine-zibi; Partridge river.

54. Mesabi hights is missabe-wudjiu or Giant mountain.

[N. B.—Missabe is a giant of immense size and a cannibal. This is his mountain, consequently the highest, biggest mountain.*]

55. Cloquet river is Ga-bitotigweiag-zibi. The-river-that-runs-parallel-or-double; so called from running parallel with lake Superior, making a double with it.

56. Lake of the Woods is Babiquawanga. The-lake-full-of-sand-mounds-there drifted about like snow by wind.

57. Rainy lake is Kotchitchi-sag, meaning according to some, Neighbor lake, according to others a lake somewhere, (a difficult word.)

58. Rainy Lake river is Kotchitchi-zibi, meaning either Neighbor river or river somewhere, (not a strictly Ojibwe word.)

59. The river from Rainy lake up toward lake Superior is called Ga-manitigweia-zibi, or Bad-flowing-river.

[Here follow the names of some places beyond the boundary.]

60. White Fish bay is Ga-atikumegokag-sag, or White Fish lake.

61. Crow lake is Gagagiwi-sag. Raven lake.

62. Sabaskang bay is Shibashkang, "where they go winding about to find passage," among the islands.

63. From White Fish bay to Manito river, the river is called Ga-manitigweians, or The-little-bad-flowing-river.

64. The name of the river north of Hunter's island is called Ga-wasidjiwuni-zibi, or River-shining-with-foam-of-rapids.

65. Kabet-to-go-ma lake is Ga-bitogumag-sag, meaning The lake-that-lies-parallel-or-double, namely with Rainy lake.

66. Loon lake is Mango-sag, meaning Loon lake.

67. Lac-la-Croix is Sheshibagumag-sag. The-lake-where-they-go-every-which-way-to-get-through.

68. Vermilion lake, Onamuni-sag. Vermilion lake.

69. The nameless river running from Eagle's Nest lake to Vermilion lake is called Eshqueguma-zibi, or Last river, from the fact that it rises in Eshqueguma-sag or Last lake, which is not

*The Chippewas at Grand Portage represent Missabe as entombed in the hills near there; the various hills representing different members of his body.—[N. H. W.]

named on the map but is the next lake to Birch lake and north of west end of same.

[N. B.—Rivers are by the Ojibways nearly always named from the lakes, out of which they flow as in this instance.]

70. Net lake is Asubikone-sag, meaning Taken-or-entangled-in-the-net-lake.

71. The river flowing from Net lake is called Ningotawonaning or Separating-canoe-routes-river from the river forking. "Ing" is the termination at or to.

72. Big-fork river is called Atchabani-zibi or Busatchabani-zibi. Bowstring river; so called according to the usual rule from rising in Bowstring lake.

73. Bowstring lake; Atchabani-sag, or Busatchabani-sag; (it is pronounced both ways by different Chippeways), meaning Bowstring lake.

74. Little Fork river, Ningtawonani-zibi; Separating-canoe-routes-river, as explained above, No. 71.

75. Round lake, northwest of Bowstring, is Ga-wawiiegumag-sag. Round lake.

76. Big White-face river is Kitchi-wabishkingwewe-zibi. Big white-face river.

77. Ushkabwahka river is Ushkibwakani-zibi. The-river-of-the-place-of-the-wild-artichokes.

78. East Savanna river, Mushkigonigumi-zibi. The-marshy-portage-river; from the marshes or low lands bordering the river, making the portages over marshy ground.

79. East Swan river, tributary of the St. Louis, is Wabiziwi-zibi. Swan river.

80. Grand lake, near St. Louis river, is Kitchi-sagaiigun; or Grand lake.

81. Canozia lake is Ga-ginogumans-sag, or Little Long lake.

82. Wild Rice lake, back of Duluth, is Megwewudjiwmano-minikan. The-place-of-wild-rice-amidst-the-hills.

83. Prairie lake is Mushkodensiwi-sag, or Little Prairie lake.

84. Prairie river is Mushkodensiwi-sibi, or Little Prairie river.

85. Minnesota point (at Duluth) is Shagawamik, meaning the long-narrow-point; "ing" to or at the long narrow point, as usual.

86. Rice's point — near Duluth within city limits — Wubish-ingweka, meaning the narrow contraction (of the river) caused by the point covered with little pines.

87. Fond-du-Lac is Nagadjiwanang, where the flow of the water stops or is arrested; "ang" the usual termination to or at.

88. Dalles of the St. Louis from Thompson down. Kitchi Kakabikang; the great fall,— "ang" at or to.

89. Sandy lake, Aitkin county. Ga-mitawangagumag-sag. Referring to the character of the soil in which the lake is situated. The-place-of-bare-sand-lake, or Sandy lake.

90. Perch lake on N. P. R. R. near Junction; Atawemego-kag-sag. The-place-where-the-fish-fire-goes-out-lake, that is the place where the fishes die for want of air, being in too shallow a place, and freezing up.

91. Knife falls. Mokomanonigum. Knife portage.

92. Island lake, N. P. R. R. Ga-minisiwung-sag. Island lake.

93. Rice lake, south of Sandy lake, Kitchi-manominikani-sag. The-great-place-of-wild-rice-lake.

94. Willow river (east of Mississippi nearest Aitkin), Moinu-jewi-zibi, meaning Dung-on-the-skin-river.

95. Wakonabo-sag. The lake of the broth of Wakwug or fish-melt, or eggs-broth-lake; or Broth-of-moss-growing-on-rocks-or-trees-lake.

[N. B.—The Indians use the latter in case of starvation. Both the above explanations are given by different Indians.]

96. Moose river is Moz-oshtigwani-sibi; or Moosehead river.

97. Moose river heads in some little lakes called Nodaishi-baning; or The-place-of-hunting-ducks-lakes.

98. Willow river, north of Moose river, is Ozisigobimiji-zibi.

99. Hill lake is Pikwudina-sag, or Hill lake.

100. Nameless lake south of Pokegama and about six miles west of the Mississippi is called Ushigunikan-sag, meaning Bass lake or The-place-of-bass-lake.

101. Prairie river on Mississippi is Mushkodensiwi-zibi, or the river of the little prairies. Little Prairie river.

102. The lake on the above river is the same, Mushkodensiwi-sag, or Little Prairie lake.

103. Trout lake, Namegosi-sag. Trout lake.

104. Swan river, east of last, is Wabiziwi-zibi, or Swan river.

105. Deer lake north of Pokegama is Wawashkeshiwi-sag, or Deer lake.

106. Trout lake, north of above, is Namegosi-sagaiigun, or Trout lake.

107. Spider lake, north of above, is Asubikeshi-sagaiigun.

108. Stephens lake is Wawashkeshiwi-sag, or Deer lake.

109. Ball-club lake is Pagautowan, or Ball-club lake, being the instrument they hold in their hand and play with, the game of La-Crosse.

110. Bass lake (south of Deer lake) Ushigunikan-sag. The-place-of-bass-lake.

111. Mud lake (on Leech lake river). Ga-bagodjishkiwugag-sag, meaning shallow-mud-bottomed-lake.

112. Quaim-butch-e-weg-e-mug south of Pokegama lake, is Ga-wimbudjiwegumag. The-lake-that-lies-in-the-hollow-of-the-mountain.

113. Sinzi-ba-quat-sag, west of last, is correct, means sugar lake.

114. Vermilion lake, above lake Pokegama, is Onamuni-bigokag-sag, meaning Vermilion lake.

115. Nameless lake, long shaped, between Leech lake river and Winnibigoshish lake, is named Kitchi-bugwudjiwi-sag, meaning big-lake-in-the-wilderness or big-wilderness-lake.

116. Winnibigoshish is correct; means miserable-wretched-dirty-water, (Winni, filthy; bi, water; osh, bad, an expression of contempt; ish, an additional expression of contempt, meaning miserable, wretched).

117. The promontory on west shore of Winnibigoshish is named Gagagishibeneashi, or Raven-Duck point. The stream that comes in there has same name.

118. The nameless lake, west of Winnibigoshish, is Bitowi-manominikan-sag. Parallel-rice-field-lake, or Double-rice-field-lake.

119. Cass lake is Ga-misquawakokag-sag, or The-place-of-red-cedars-lake, from some red cedars growing on the island; more briefly Red Cedar lake.

120. The large island in the lake was anciently called Gamis-quawako-miniss, or the island of red cedars. It is now called Kitchi-miniss or Great island.

121. The little pond, nameless on the map, two miles south of the extremity of lake Itasca, from which the farthest drop of water comes to the Mississippi, has no name given to it by the Indians; it was first named by the writer lake Whipple in honor of the first bishop of Minnesota.

122. Elk lake — on the map so called — separated from lake Itasca by a narrow piece of land and south of same is called by them Pekegumag-sagaiigun. The-water-which-juts-off-from-an-

other-water. It was first named by the writer Breck lake, in honor of the distinguished first missionary of the American church to St. Paul and vicinity, who was afterwards first missionary of the church to the Chippewa Indians around the sources of the Mississippi.

122½. The river (nameless on the map) running from above lake is Pekeguma--sibiwishi, or brook-of-the-water-which-juts-off-from-another-water.

123. Itasca lake has been called by the Indians, from time immemorial, Omushkozo-sagaiigun; Elk lake.

124. The Mississippi running thence is called Omushkozo-sibi from lake Itasca till it reaches the lake.

125. Lake Bemidji is Bemidjigumag-sagaiigun, or the lake where the current flows directly across the water, referring to the river flowing squarely out of the lake on the east side, cutting it in two as it were. Very briefly Cross lake. The-lake-where-the-current-flows-directly-across-the-water.*

126. From lake Bemidji to Cass lake the river is called Bemidjiguma-sibi, or Cross river.

[For fuller description see No. 439.]

127. From Cass lake to Winnibigoshish it is called Ga-misk-quawakoka-zibi; Red Cedar river, or river of the place of red cedars.

128. From outlet of Winnibigoshish to mouth of Leech Lake river it is called Winnibigoshish-zibi; Winnibigoshish river.

129. Below the junction of Leech Lake river it is called Kitchi-zibi, or Great river.

[N. B.— I can not find by inquiry that the Chippewas have ever called it Missizibi (Mississippi) or Missazibi. But I consider it very probable that in remote times they did, for Missa-zibi (Mississippi) would express the same idea in their language, and would be proper, as witness Missa-sagaiigun (Mille Lac) meaning Great lake. It so exactly corresponds with their language that it must have been taken from it.]

130. Upper Rice lake—on the map—northwest of lake Itasca, is Ajawewesitagun-sag, meaning the lake where there is a portage from water running one way to waters running the opposite way, or briefly, Hight-of-land-lake.

131. Red lake is Misquagumiwi-sagaiigun. Red-water lake, so called perhaps from a sort of reddish, fine gravel or sand along the shore in places, which in storms gets wrought into the water near the edges. By others so called from being sometimes of a

*Others interpret it as meaning the same as the French *Travers*, i. e., where it is necessary to go directly across the body of the lake in passing up or down the Mississippi.—[N. H. W.]

reddish color from streams running from the bogs north of the lake, the water from which streams is of a reddish color.

132. Red Lake river is Misquagumiwi-sagaiiguniwi-zibi (Red-Lake river) to Red river.

133. The narrow point of land running west in Red lake, dividing it almost into two, is called Wabashi-ing at or to Wabashi. Wabashi means the straits; something contracted.

134. Crookston on Red Lake river is called Asadi-minaqwam. The-poplar-grove.

135. Roseau river in Kittson county is Ga-shashagunushko-kawi-sibi, or the-place-of-rushes-river, or briefly, Rush river.

136. The next river south, namely Two Rivers, is Ga-nijoshino-zibi, or the-river-that-lies-two-together-as-in-a-bed; no doubt, from its two branches running parallel.

137. Tamarack river is Ga-mushkigwatigoka-zibi, Tamarack river.

138. Snake river, next south, is Ginebigo-zibi, Snake river.

139. Sand Hill river is Ga-papiqwutawangawi-zibi, or the-river-of-sand-hills-scattered-here-and-there-in-places.

140. Clearwater river, Polk county, is Ga-wakomitigweia-zibi, or Clearwater river.

141. The South fork of Clearwater river is peqwudina-zibi, Hill river.

142. The lake, nameless on map, in which the above South fork of Clearwater river rises is Ajegunegamga-shingwakokag-sag, the-lake-with-pines-on-one-side-of-the-water.

143. The lake, nameless on map, southwest of last, is called Mekinako-sag, or Turtle lake, from its form, which, seen from a canoe in the middle, closely resembles a turtle.

144. Poplar river, Polk county, is Asadi-zibi, or Asadikawi-zibi; the former meaning poplar river; the latter Place-where-poplars-are river.

145. The river, nameless on map, south of South fork of Clearwater and running into Clearwater river, is Kitchi-zibi-wishi, or Big brook.

146. The lake, nameless on map, south of source of last-named creek, and near the present town of Fosston, Polk county, is Pugwundumokan-sag, or the-place-of-suffocated-fish lake, that is, where the fishes die for want of air, and are seen dead.

147. Middle river, Marshall county, is Nessawitigweia-sibi, or Midde-flowing river.

148. Wild Rice river is Ga-manominiganjikawi-zibi. The-river-where-wild-rice-stalk or plant is growing; so called from the last lake through which it flowed.

149. The south branch of Wild Rice river is Ga-tchekatigweia-zibi,or Ga-tchatchwequatigweia-zibi. The-river-that-thrusts-into-something-and-disappears; referring to its sinking into the ground and disappearing for some time.

150. The large lake, nameless on map, called Maple lake by the whites, near Maple bay and Mentor, Polk county, is Ga-shabwewegumag, meaning the-lake-that-forces-itself-through-the-timber-in-a-long-bay.

151. Thief river is Kimod-akiwi-zibi. The-stolen-land-river or Thieving-land-river. For the meanings see Warren's History.

152. Elbow lake, in which the Red River of the North rises, is Ga-odoskwunigumag, or Elbow lake.

[N. B.—The little pond six miles N. E. of it, from which a little stream comes and which may be called the source of the river, is unnamed by the Indians.]

153. The river coming from Elbow lake is called Ga-odoskwuniguma-zibi, or Elbow Lake river, according to the usual rule.

154. Many-point-lake, Ga-muminewamiwung-sag. The-lake-with-bays-running-in-all-directions is next on stream.

155. The river running out of above lake is according to usual rule, Ga-muminewami-zibi. Bays-in-all-directions river.

156. The next lake, nameless on map, three miles southwest of last and of long shape, is Ga-wawunokag-sag, or the-place-of-eggs lake.

[N. B.—There are a number of smaller lakes there. They are all called Egg lakes.]

157. The river thence to next lake is Ga-wawunoka-zibi, or Egg river.

158. The next lake, the large one, nameless on map, east of Flat lake, is Ga-bagwag, or Shallow lake.

159. The river, nameless on map, flowing thence is called Ga-bagwag-sibins, or Shallow-lake-little river until it is joined by the Round Lake river.

160. The next lake, nameless on map, through which it flows is the small lake north of Hight-of-Land lake named Assig-inako-manominikani-sag, or the-blackbird-place-of-wild-rice lake.

161. The river flowing thence is Assiginako-manominikani-zibi, or the black-birds-place-of-wild-rice river.

162. Hight-of-Land lake, the next, is Ajawewesitagun-sag, the lake-where-the-portage-is-across-a-divide-separating-water-which-runs-different-ways, or Hight-of-Land lake.

163. The river flowing thence has the same name, Ajawewesitagun-zibi or Hight-of-Land river.

164. The next lake is a little one, south of Frazee City — nameless on map — called Manominikan-sag or the place-of-wild-rice lake, but the river still retains its former name of Ajawewesitaguni-zibi to the next lakes. Twin lakes.

165. Little Pine lake and Pine lake are called Ganijogumag-sag, or Twin lakes.

166. The river issuing thence is called Ga-nijoguma-zibi, or Twin Lake river till it enters Rush lake.

167. Rush lake is Ga-shashagaunushkokag-sag, the place-of-rushes lake.

168. The river issuing thence is called Ga-shashagunushka-ka-zibi till Otter Tail lake.

169. Otter Tail lake is Nigigwanowe-sag. Otter-tail lake.

170. The river issuing thence is called Nigigwanowe-zibi, till its junction with the Bois de Sioux river, notwithwstanding it passes through.

171. A lake, nameless on the map, close to Otter Tail and southwest of same, called Wawashkeshiwi-sag. Deer lake.

172. The next lake it flows through is Ga-wimbudjiuwe-gumag-sag, or the-lake-that-lies-in the-hollow of-the-mountain.

173. Red River of the North from its junction with Bois de Sioux river is called by the Ojibways simply Kitchi-zibi. Great river.

174. Lake Travers is Ga-edawaii-mamiwung-sag. The-lake-with a-breast, or pap (like a woman's) on either end; one on the northern, and one on the southern; (flowing into Big Stone lake in high water); so flowing either way.

175. Bois de Sioux river is Ga-edawaii-mami-zibi, or the-paps-on-either-end-river.

Names of the rivers on west bank of Red river from north to south are as follows:

176. Pembina river, Anibinani-zibi, meaning the-high-bush-cranberry-river.

177. Tongue river is Odenaniwi-zibi. Tongue river.

178. Park river is Shiwitaguni-sibins. Little Salt river.

179. Forest river, Shiwitaguni-zibi. Salt river.

180. Grand Forks, Kitchi-madawang. The big forks; that is where the rivers are so large in either fork that you don't know which to go into.

181. Turtle river, Mikinako-zibi. Turtle river.

182. Goose river, Nik i-zibi.

183. Elm river, Anibi-zibi.

184. Maple river, Ga-ininatigoka-zibi. Place-of-maples-river.

185. Cheyenne river, Ga-ninaweshiwi-zibi. The-river-of-the language-that-we-almost-understand. That is what they call the Cheyenne Indians. Ga-ninaweshiwug.

186. Wild Rice river, Ga manominiganjikani-zibi. The river where the wild rice stalk or plant is growing.

187. Rush river, Ga-shashaganushkokani-zibi. Rush river or the-river-of-the-place-of-rushes.

188. White Earth lake, Ga-wababigunikag-sag. The-place-of white-clay-lake; so called from the white clay which crops out in places at the shore of the lake.

From the lake is taken the name of the reservation and adjoining region.

189. White Earth river, named from the lake, is Ga-wababigunika-zibi. White Earth river, according to usual rule named from the lake.

190. Tuliby lake, Ga-odonibinsikag-sag. The-place-of-tulibies-lake.

191. The river running thence to next lake is Ga-odonibinzikag-sibiwishi. Tuliby creek.

192. The nameless lake down the stream and northeast of White Earth lake is Shushuginsikan lake, or the-place-of-young-herons-lake.

193. The river flowing thence is Shushuginsikani-zibins, or the-place-of-young-herons-little-river.

194. Twin lakes, eighteen miles N. E. of White Earth on road to Red lake, Ga-nijogumag. Twin lakes.

195. The river thence flowing, Ga-nijo-gumag-sibiwishe. Twin lakes creek.

196. Strawberry lake, Ga-odeiminikag-sag. The-place-of-strawberries-lake.

197. Round lake, Ga-wawiiegumag-sag. Round lake.

198. Lake — nameless on the map — one mile south of Round lake, Ga-nita-mumudweqwuding-sag. The-lake-which-keeps-cracking-and-roaring-with-the-cold.

199. The lake — nameless on the map — directly N. E. of Strawberry lake, is Ga-wajushkokag-sag. The-place-of-muskrats-lake.

200. The lake — nameless on the map — between Round lake and Shell lake just south of road to Leech lake, is Ga-shagawigumag. The-long-narrow-lake.

201. The large lake, nameless on the map, three miles north of

Shell lake, is Ga-kitchigumiwushkokag-sag, meaning the-lake-of great-rushes, (the kind out of which the Indians make their rush mats.)

202. The large lake, not down on map, 28 miles S. W. of Red lake on road to same, is Nio-gade-sag, or four-legged lake; from an old Indian of that name who lived there.

203. The large lake, nameless on map, 18 miles S. of Red lake, near road to White Earth is Ga-wakomitigweia-sag. Clear-water River lake.

204. Shell lake, Becker county, is Ga-tchigudjiwegumag-sag. The-lake-lying-near-the-mountain.

205. Shell river flowing from above is Ga-tchigudjiweguma-zibi. Mountain Lake river.

206. The lake, nameless on the map, about nine miles directly southwest of Elk lake, so called, is Ga-wigobi-minising or bass-wood-little-island-lake.

207. Toad lake is Mukuki-sag. Toad lake.

208. Toad river is Mukuki-sagaiiguniwi-zibi. Toad lake river.

209. Lake Colton or Cafton, south of Tamarack lake, is Ga-minisabikowung-sag. The-lake-with-the-rocky-island.

210. Tamarack lake is Ga-mushkigwatigokag-sag, or the-place-of-tamaracks-lake.

211. Flat lake is ———

212. Straight lake, Ga-gwaiukwitgweiag-sag. Straight-flowing-lake.

213. Straight river, Ga-gwaiukwitigweia-zibi. Straight-flowing-river.

214. Buffalo lake, Becker county, is Obiningutoway-sag. The lake-where-it-keeps-crumbling-away-from-the-beaver's-gnawing.

215. The river flowing thence, on map Buffalo river, is Obiningutoway-zibi. The-river-where-it-keeps-crumbling-away-from-the-gnawing-of-beavers.

216. The river — nameless on map — which comes from Audobon and flows into the above is called Pijikiwi-zibi, or Buffalo river, from the fact that buffaloes were always found wintering there. Hence the white people have erroneously called the whole river Buffalo river.

Source and course of the Pelican river.

217. Lake Gilchrist is Nishiwe-sag. All-murdering-lake.

218. The stream thence is called Nishiwe-sagaiiguniwi-zibi-wishe or murdering-lake-creek, to Floyd lake.

219. Floyd lake is Migizi-wuziswuni-sag, or Eagle's Nest lake.

220. The creek thence flowing is Migizi-wuziswuni-zibiwishe, or Eagle's-Nest-creek.

221. Next lake, nameless on map, is Manominiganjiki-sag—north of Detroit—the-lake-in-which-wild-rice-grows, or wild rice field lake.

222. The creek thence flowing is Manominiganjiki-zibiwishe. Rice-growing-creek, to Detroit lake.

223. Detroit lake is Ga-ajawaangag-sag. The-lake-in-which-there-is-crossing-on-the-sandy-place.

224. The river flowing thence. marked on some maps Pelican river, is Ga-ajawaanga-sibiwishe, or Detroit-lake river.

225. The next two lakes, on some maps called lakes Sully and and Amelia, are Ga-nijo-gumag. Twin.lakes.

226. The next lake, nameless on any map, through which the river flows, a small one, is called Ga-bi-midji-sagitawag sag, or The-lake-which-is-squarely-flowed-across (by the river) at its outlet.

227. The next. Pelican lake, on map, through which the river runs, is Ga-pushkodewegumag-sag. The-lake-with-the-smooth-shorn-prairie-coming-down-to-it-on-one-side.

228. Lake Lida, as it is put down on the map, the next through which the river runs, is Shede-sagaiigun-ajawakwa, Pelican-lake-beyond-the-timber, to distinguish it from the other Pelican lake.

[N. B.—Both parts of this great lake, separated by a narrow causeway over which a road now runs, are called by the same name, Pelican lake.]

(229 is wanting.)

230. The river flowing thence is called Shede-sagaiiguniwizibi, or Pelican-lake river.

231. Prairie lake is Oobe-sag. Oobe lake, from an old Indian of that name killed there by Sioux.

232. Fergus Falls is Kakabikans. The-little-squarely-cut-off-rock, or little fall.

233. The lake, nameless on the map, southwest of White Earth lake, on right hand of road leading to Leech lake, is Pugitawewin The-place-of-setting-nets.

234. The lake—nameless on map—6 miles south of lake Itasca, has no distinctive name given to it; is called merely Sagaiigun. The lake.

235. The lake—nameless on map—12 miles south of lake

Itasca, is Tchigudjiwegumag-sag. The-lake-lying-along-by-the-mountain.

236. Fish-Hook lake is Pugidabani-sagaiigun. Fish-hook lake.

237. The lake— nameless on map —just north of Fish-hook, is Ga-nijo-sagiwung. The-lake-with-two-outlets.

238. The river flowing south from Fish-hook lake is Pugidabani-zibi. Fish-hook river.

239. Pine river on Mississippi is Shingwako-zibi, or Pine river.

240. White Fish lake in same locality is Ga-atikumegokag-sag. The-place-of-white-fish-lake.

241. Cross lake, S. E. of White Fish, is Ga-bimidjigumag-sag. The-lake-which-the-river-flows-directly-across.

242. Daggett Brook lakes are Tchigawe-sag. Cutting-the-hair-off-the-skin-lakes.

243. Crooked lake is Wewagigumag-sag. Crooked lake.

244. The lake, nameless on map, just east of Crooked lake, almost touching it, is Buke-sagitawag. A-lake-forming-the-arm-of-river.

245. The next lake, nameless on map, northeast of last, is Ga-shagawigumag-sag. The-long-narrow-lake.

246. The next, nameless on map, is Manominiganji-kans. The little-place-of-wild-rice-growing-lake.

247. The little lake, nameless on map, between White Fish lake and Cross lake, is Shingwakosagibid-sag. The-lake-of-the pine-sticking-up-out-of-the-water.

248. The first enlargement on Pine river proceeding from the Mississppi is Bukweiawibia, meaning an enlargement-of-the-river.

249. The next is Ga-bagwag-sag. The shallow lake.

250. Norway lake is Ga-tchibo-sagitawag. The-lake-where-the-river-goes-quartering-across-it-diagonally, not straight.

251. Pine lake on Leech lake road is Ga-tchigudjiwegumag-sag. The-lake-lying-near-the-mountain.

252. The lake—nameless on map—two miles east of last is Manominiganijikans. The-little-place-of-wild-rice.

253. The next lake east—nameless on the map—is Mukundiwi-sag. Plundering lake; no doubt from the pillage which once took place there, from which the Pillagers took their name, as recorded in Warren's History.

254. Lake Lottie is Metawanga-sag. Sandy-beach lake.

255. The lake—nameless on the map—two miles N. W. of lake Lottie is Iquewi-sag. Woman lake.

256. The lake — nameless on the map — two miles N. W. of last is Wibogijigikag-sag. Cedar-narrows lake.

257. Woman lake is Iquewi-sag. Woman lake.

258. Little-boy lake is Quiwizensiwi-sag. Boy lake.

[N. B.—The last two named are so called from women and boys respectively, they having been killed in those lakes by the Sioux during an irruption made by them.]

259. The lake — nameless on the map — south of Boy lake is Wabuto-sag, or Mushroom lake.

260. Boy river is Quiwizensiwi-zibi. Boy river.

261. The enlargement on Boy river is Manominiganjiki, or The-rice-field.

262. Boy lake, next to Leech lake, is Quiwizensiwi-sag. Boy lake.

263. The spur of a lake, nameless on map, running S. E. from Boy lake is Ningitawonan-sag. Separating-canoe-route-lake.

264. The lake, nameless on map, in which the last mentioned heads is Mikinako-sag. Turtle lake.

265. Two little lakes, on thread of above stream, before coming to Turtle lake, nameless on map, are Mushkigwaguma. The Swampy lakes.

266. Big Rice lake, in which heads Willow river, is Nodaishiban, meaning the-place-of-hunting-ducks, i. e. from the multitude of ducks going there to eat wild rice.

267. Leech lake is Ga-sagasquadjimekag-sag. The-place-of-the-Leech-lake; from the tradition that on first coming to it, the Chippeways saw an enormous leech swimming in it.

268. Ten-mile lake, Namegosi-sag. Trout lake.

269. The large promontory in Leech lake stretching N. E. toward Cass lake is Shingwakoneashi, or Pine point.

270. The lake — nameless on map — directly south of Ten-mile lake is Ga-wigwasensikag-sag. The-place-of-little-birches-lake.

271. Long lake, south of Frazee City, is Ga-gawandjikag-sag. Juniper lake.

272. The lake, nameless on map, north of last is Ga-ishwassomikwed-sag. Eight-beaver lake.

273. The two little lakes east of last are called Manido-sag-aiiganun. Spirit or God lakes.

274. The somewhat large lake east of Frazee City and north of the Northern Pacific railroad is Ga-ajawitawangans-sag. The-lake-with-a-little-crossing-on-bar-of-land-across-it.

275. The lake, nameless on map, west of Otter Tail lake, north part, is Ga-bitawigumag-sag. Parallel lake or Double lake, from its lying parallel or double with Otter Tail lake.

276. The lake S. W. from Leaf lake, marked lake Godard on maps, is Ga-ajawaangans-sag. The-lake-with-the-crossing-on-a-spit-of-sand, so named from the little portage of sand from it into Leaf lake.

277. Leaf hills are Gaskibugwudjiwe. Rustling-leaf-mountain.

278. Leaf lake, Gaskibugwudjiwe-sag, or Rustling-leaf-mountain lake.

279. Leaf river, Gaskibugwudjiwe-zibi. Rustling-leaf-mountain river.

280. Partridge river isBine-zibi. Partridge river.

281. Battle lakes are Ishkwunidiwini-sag. Mutual-extermination lakes.

[N. B.—A great slaughter of Chippeways by Sioux took place there many years ago.]

282. Lake Clitheral, Gagawandjikag-sag. Juniper lake.

283. Lake Stellar in Tordenskjold township, Otter Tail county, is Odadjigaoni-sag. Garfish lake.

284. The river coming from last is Odadjigaoni-zibi. Garfish river.

285. Lake Christianson is Ga-wubatawangag-sag. The-lake-with-the-contracted-place-formed-by-an-isthmus-of-sand.

286. Lake Pomme de Terre is Opinikani-sag. The-place-of-wild-potatoes-lake.

287. The river running from same is called Opinikani-zibi The-place-of-wild-potatoes-river.

288. Two Elbow lakes, southwest of Pomme de Terre, are Ga-odoskwunigumag-sag, or Elbow lakes.

289. The lake — nameless on map — in Eagle Lake township is Migizi-wuziswuni-sag. Eagle's Nest lake.

290. Osakis lake is Osagi-sag. The Sauk's lake.

291. Crooked lake near Osakis, Wewagigumag-sag, i. e. Crooked lake.

292. Sauk lake is Kitchi-o-sagi-sag. The great lake of the Sauks.

293. Birch bark-fort-lake, Ga-wigwassensikag-sag. The-place-little-birches lake.

294. Long Prairie river, Ga-shagoshkodeia-zibi. Long-narrow-Prairie river.

295. Sauk river, Osagi-zibi. The river of the Sauks.

296. Minnesota river, Ushkibugi-zibi. Greenleaf river.

297. St. Paul, Ushkibugi-zibi. Greenleaf river.

298. Minneapolis, Kitchi-kakabika. The Great Fall; very literally, the great squarely-cut-off rock.

299. Gull lake, Ga-gaiashkonzikag-sag. The-place-of-young-gulls lake.

300. Round lake, Ga-wawiiegumag-sag. Round lake.

301. Cubert lake, Ga-manominiganjikag-sag. Wild-rice lake.

302. The northern prolongation of Gull lake is called Ga-ginogumans. The-little-long lake.

303. Crow Wing river, Gagagiwigwuni-zibi. Raven-feather-river.

304. Nameless lake — on map — 7 miles N. W. of Park Rapids, Hubbard county, called by whites, Elbow lake, is Ga-adjudjequatigweiag-sag, means very literally, "The-lake-into-which-the-river-pitches-and-ceases-to-flow; — dies there." (That is, it has no outlet.)

305. Mille Lac lake, misa-sag. An Archaic word meaning every-where lake or Great lake.

306. Crow Wing village, Ningitawitigweia. The-forking-of-the-rivers.

307. Gull river, Ga-giashkonsika-zibi. Gull river.

308. Nokesippi is Noke-zibi. Noke's river.

[N. B.— Noke is a man's name, found only among the dodem or Clan of the Bears, so this means "the dodem of the Bear's river."]

309. Lake Alexandria near Fort Ripley, Shumano-sag. From an old Indian named Shumanons, who lived there long ago, from whom the Indians named the lake.

310. Little Elk river, Omushkozo-zibi. Elk river.

311. The prairie north of Belle Prairie, where the railroad runs along the river — Tchi-kishkutawangag. Meaning Big-cut-sandy-bank-place.

312. Little Falls, Kakabikans. The Little fall.

313. Swan river, Wabiziwi-zibi. Swan river.

314. Two-rivers, Ga-nijotigweiag-zibi. Two-flowing-rivers.

315. Long lake on Nokezippi, Gaginogumag-sag. Long lake.

316. Round lake; small lake down the stream, Noke-sag. Noke lake.

317. Platte lake, Pequishino-sag. Hump-as-made-by-a-man-lying-on-his-hands-and-knees-lake.

318. Platte river, Pequishino-zibi. Hump-as-made-by-a-man-lying-on-his-hands-and-knees-river.

319. Small lake — nameless on map —at Gravelville, Nisawudina-sag. Lake-in-the-midst-of-mountains.

320. Little Rock river — Piquabika-zibi, Little Rock river, meaning the river where the little rocky hills project out every once in a while, here and there.

321. Sisseton Agency, Dak. Ter., Ogimawudjiu, or King mountain.

322. Frazee City, Minn., Ga-shabwakwumok. Where-the-road-passes-out-of-the-timber.

323. Lake — nameless on the map — north of Manter, Hubbard county, Ga-ogikutanaugokag-sag. The-place-of-the-lizards-lake.

324. Red Eye river — Miskoskindjigo-sibi. Red Eye river.

325. Lake — nameless on map — 8 miles directly west of 10-mile lake, Ga-ajogune-mushkodewung-sag. The-lake-with-prairie-on-one-side.

326. Shingobi minisensiwi-zibi, a river running into Leech lake, is correctly named; means Little-balsam-island river.

327. The lake — nameless on map — 3 miles west of that river, being the first from Leech lake, is Ga-ginogumag-sag. Long lake.

328. The next is Ga-ouamunikag-sag. Vermilion lake.

329. Kabekuna lake is correct — means The-end-of-all-roads lake.

330. Niki-miniss is Goose island in Leech lake; correct.

331. Bear island is Muko-miniss; correct.

332. Pelican island is Shede-miniss. Pelican island.

333. The point — nameless on map — running south into the centre of Leech lake is Nigigwanow. Otter Tail.

334. Grand Rapids, below Pokegama fall, is Ga-ganwadjiwanang. The-long-rapids.

335. White Oak point is Nemijimijikan. White Oak point.

336. Pelican lake, north of Gull lake, Shede-sag. Pelican lake.

337. Pike lake, near Mille Lac, Wijiwi-sag. The-lake-full-of-muskrat-houses or beavers.

338. Heron lake, north of Mille Lac, Pepiqueweg-sag, Echo-lake, means where the sound of a call returns in an echo.

339. Mud lake, Pepushkodjishkiwugag-sag, means Thick-mud but smooth as it were shorn lake.

340. Cedar lake — near Aitkin — Ga-misquawakokag-sag. Red Cedar lake.

341. Serpent lake, Newe-sag. Blow-snake lake.

342. Rabbit lake, Wabozo-wakaiiguni-sag. Rabbit's-House lake.

343. Ogeshie lake, the nearest outlet of Mille Lac, is Netumigumag, meaning First lake.

344. Nessawe — next lake on river — is Nessawegumag. Middle lake.

345. Onamuni lake is Eshquegumag. The last lake.

346. Rum river is Missa-sagaiiguniwi-zibi. Mille Lac lake river, literally Everywhere-lake river.

347. Princeton is Ningitawitigweiang. The-place-where-the-rivers-fork.

348. Hanging Kettle lake is Akik-agodjina-sag. Hanging Kettle lake.

349. The lake — nameless on map — just east of the middle of Mille Lac and very near to same is Mishidonshi-wakaiiguni-sag. The miserably-bearded-one's-house-lake. This is so-called from a Frenchman, a trader *with a thin straggling beard*, who had his trading-post at this lake.

350. Skunk river is Shingwakozowe-zibi. Pine-tail river.

351. The island in S. W. part of Mille Lac is Kitchiminiss. Big island.

352. The small, three-pronged lake — nameless on map — S. W. of trading post at N. E. corner of Mille Lac, is Pupushqua-minissensiwi-sag. The-little-shorn or cleared island lake.

353. Island — nameless on map — in Leech lake on way to Cass lake is Ajawiu.

354. Lake — nameless on map — the first out of Leech lake on way to Kabekona, is Wubitigweia-sag. The-lake-made-by-a-contraction-of-the-flowing of the river.

355. The lake — nameless on map — to the southwest of last and very close to it, is Ga-ajawush-quagumag-sag. Green-water lake.

356. The river extending N. W. is Kabekona-zibiwishe. The-end-of-all-roads creek.

357. The name of the river extending from Leech lake up to steamboat landing is Ga-misqua-wakokag-sibiwishe. Red Cedar brook or creek.

358. The lake — nameless on map — lying nearly due west from end of the last river, is Ga-buke-sagitawag. The-lake-forming-an-arm- (or outburst) of-a-river.

359. The river — nameless on map — running out of last

named lake N. W. toward Bemidji lake, is Ga-gibinewenitizo-zibi. The-river-where-the-person-hanged-himself.

360. The lake whence the above river issues — perhaps called lake Grave on map — is Ga-gibinewenitizo-sag. The-lake-where-the-person-hanged-himself.

361. Dead lake near Otter Tail lake is Tchibegumigo-sag, or House-of-the-Dead-lake.

[N. B.— A grave is called house of the dead, from the custom of the Indians to build the resemblance of a little house over a grave.]

362. The river issuing from said lake is Tchibegumigo-sibi-wishe, or House-of-the-Dead-creek.

363. Star lake is Shede-sag-nawakwag. Pelican-lake-in-the midst-of-the-timber.

[N. B.— The above named Pelican lakes were all called so from being covered with Pelicans in old times.]

364. Brainerd is Oski-odena. Newtown.

365. Where the Roman Catholic church is, above Little Falls is Kitchi-kitiganes. The-great-little-field.

366. The German village, a little higher up the river than Gravelville lake, on Platte river is Babik-wajibikang. The-place-where-the-rocky-strata-underneath-keep-cropping-up in the rocky mounds scattered here and there.

367. St. Cloud is Sagi-zibi. The Sauk's river.

368. The Trading Post below Mille Lac, Kibakwaiigun. The Dam.

369. Cormorant lake, Becker county, is Ga-gagishibensikan. The-place-of-little-Cormorants, i. e., from their nesting there.

370. Little Cormorant lake is Ga-shishibagumag-sag. The-lake-which-runs-every-which-way.

371. The lakes at Lake Park—nameless on map—are Newad-inibuganssing-sag, meaning, the-lakes-where-there-are-streams-groves-prairies-and-a-beautiful-diversified-park-country.

372. Lake Eunice, Becker county, is Ga-gibishe-sag. Deaf lake.

373. The somewhat large lake — nameless on map — up the stream from Dead lake and about two miles west is Wejawush-quagumi-sag, or Lake-with-the-water-green-as-grass, from the intensely green color of its water.

374. The good-sized lake in Norwegian Grove township — nameless on map — is Bimadagutchigun-sag, or Driven-to-bay-in-the-water-lake, from the Sioux having once at that place suddenly attacked the Chippeways, who rushed into the water to

escape from their enemies, who took the Chippeways' own canoes, followed them into the water and cut off the heads of many of them defenselessly there.

375. The lake — nameless on map — two miles to the north of the last is Ga-minissiwung-sag. or Island lake, from its islands.

376. A little lake — nameless on map — south of Otter Tail river, between Deer lake and Lake-lying-in-the-hollow-of-the-mountains is Ga-moshkaung-sag, The-lake-where-the-water-rises-or-floods. From a periodical rising and subsiding of its waters like the tide, as the Indians report.

377. The lake — nameless on map — north of Otter Tail river, S. E. of Lake-lying-in-the-hollow-of-the mountain, is Ga-wanushkodewesing or Prairie Circle lake, so called from its shape which is a perfect circle at one end.

378. Lake St. Croix is Gigo-shugumot. Floating Fish lake.

379. Prairie La Crosse, Wis., is Bagautowaning. The-place-where-they-play-ball.

380. Prairie du Chien is Kibi-sagi, or The-outlet-that-is-stopped (that is of the Wisconsin river) by a bar.

381. Stillwater is Gigo-shugumot-odena-ga-tugog. The-town-on-the-lake-of-the-floating-fish.

382. St. Croix river is Manominikeshi-zibi. The-rice-bird-river. From this river the St. Croix Indians take their name.

383. The Dalles of the St. Croix, Wibudjiwanong. The rapids at the contraction of the river.

384. St. Croix Falls. Manominikeshi-kakabikang. The fall of the St. Croix river.

385. Sunrise river is Memokage-zibi. Keep-sunrising river.

386. Wood river, Wigobi-zibi. Basswood river.

387. Cheng-watana is properly Tchingwudinang. The steep or abrupt end of a spur of hills.

388. Cross lake, near Pine City, Bemadjigumag. The-lake-which-the-flow-cuts-across, alluding to the river flowing across the lake.

389. Snake river, Ginebigo-zibi. Snake river.

390. Pokeguma-lake, Pokeguma-sag, or Bukeguma-sag. The-lake-with-bays-branching-out.

391. The lake south of Wood river in Wisconsin, is Wigobi-sag.

392. Kettle river, Akiko-zibi; Akik, kettle; zibi, river; and o, connective.

393. Bear river is Muko-dasonaguni-zibi. Trap-for-bear-

made-by-something-heavy-as-a-log-to-fall-upon-him-catch-him-under-it-and-crush-him river. Bear-dead-fall-river.

394. Tamarack river is Ga-mushkigwatigokag-zibi. The-place-of Tamarack river.

395. Namekagon-zibi. The place of Stürgeon river or Sturgeon river (Name of a Sturgeon).

396. Totogatic river, Totogatik-zibi. Swamp-tree river.

397. Yellow lake, Wezawagumi-sag,or Yellow-water lake.

398. Yellow river, Wezawagumi-zibi. Yellow-water river.

399. Eau Claire lakes, Wis., Ga-wakomitigweiagsagaiigunun. Clear Water lakes.

400. Eau Claire river,Ga-wakomitigweia-zibi, or Clear Water river.

401. St. Croix lake, Manominikeshi-zibi-ajawewesitaguning. The-place-of-the-cut-across or Portage into Rice Bird river.

402. Lake Nebegumowin; correct meaning, The-lake-where-they-wait-in-canoes-by-night, (i. e. to shoot deer.)

403. Lake Court d-Oreilles, Ottawa-sag. Ottawa lake.

404. Grindstone lake is Shigwunabiko-sag. Grindstone lake.

405. Flambeau river, Wasswaguni-zibi. Torch river.

Rivers on lake Superior as follows:

406. Aminicon river, Aminikan-zibi. Curing-Fish river.

407. Poplar river, Ga-manazadikag-zibi. Place-of-Poplar river.

408. Burnt river, Newisakode-zibi. Burnt-wood-point river.

409. Iron river, Biwabiko-zibi. Iron river.

410. Flag river, Ga-apukwekag-zibi. Flag (a rush) river.

411. Cranberry river, Ga-mushkigimini-zibi or Cranberry river.

412. Bark point, Newigwassikang. At Birch point.

413. Siskiwit river, Siskawekani-zibi or Siskiwit river.

414. Sand river, Ga-gishkutawangawi-zibi, or The-river-with-perpendicular-high-cut-sand-banks.

415. Rice lake on White Earth Reservation is Ga-manominiganjikag-sag or The-lake-of-wild-rice.

416. Little Rock river (flowing into Red lake), is Ga-asininsikag-zibi. Little-stone-river or Gravel river.

417. Mill creek — Red lake is Ogakani-zibi, or Place-of-Pike-fish river.

418. The next river N. E. of last — nameless on map — Ondataonani-zibi. The-river-that-leads-by-canoe-to-the-place-of-destination. (i. e. Red lake.)

419. Sandy river is Waiequatawango-zibi, or the-end-of-the-sandy-beach river; because it empties at the end of the sandy beach, Red lake.

420. Sesabeguma lake, N. E. of Mille Lac, is Sesabegu-ma-sag. Every-which-way lake, or the lake which has arms running in all directions.

421. Ground-house river, Aki-wakaiiguni-zibi. Earth-house river.

422. Detroit mountain (near Detroit, Minnesota), Ashiwabiwin. Looking-out, from the Sioux having been always there on top of mountain looking out for the Chippeways.

423. The lake — nameless on map — called Oak lake by the people between Detroit and Audubon on N. P. R. R., is Gamitigomijinskag-sag, or The-place-of-little-oaks lake.

424. Fort Garry or Winnipeg, Mishtawaiang, a Cree word, meaning the-junction-of-rivers.

425. Wadena is the name of an Indian who lived at Gull lake, meaning Little-round hill.

426. Turtle lake, between Cass lake and Red lake is correct, Mikinako-sag. Turtle lake.

427. Turtle river, flowing from the same, correct. Mikinako-zibi.

428. The lake, nameless on the map, at the head of Mud river, which runs into Leech lake is Kitch-mushki-gwagumag-sag. Big-swamp lake.

429. Mud river, running into Mud lake, is Pepushkodjiskii-wuga-zibi. Mud lake river.

430. The two lakes, nameless on map, S. W. of No. 428, are Mikinako-sagaiigunun, or Turtle lakes.

431. The large promontory, nameless on map, stretching out into Leech lake, westward from village is Shingwako-neashi, or Pine point.

432. The narrows between said point and the mainland on the north are called Babigowubiguma, or the Flea-narrows.

433. Sunrise lake is Memokage-sag, or Sun-keep-rising lake.

434. Chippewa river is Ojibwe-zibi. Chippewa river.

435. Sylvan lake, near Gull lake, is Pindassonaguni-sag, or Fish-trap lake.

436. The lake — nameless on map — nearest Gull river is Mesquatawangag-sag, or Red-Sand lake.

437. The lake east of the last named — nameless on map — is Ga-mushkosiwagumag-sag, or Hay lake.

438. Two Rivers, down the Mississippi from Fort Ripley, on west side of river, is called by the Indians Opinikani-zibi, or The-place-of-potatoes river, from the Indians usually finding wild potatoes there.

439. The part of the Mississippi — nameless on the map — which flows between two points in Cass lake, where the church is on one side and the chief of Cass lake's house on the other — being less than half a mile long — is called by the Indians Wub-itigweia-zibi. The-river-that-flows-through-the-narrow-constricted-place.

VIII.

NOTES ON ILLÆNI.—BY AUG. F. FOERSTE.

The discovery in the Trenton limestone of Minnesota of an *Illænus* of the type represented by *I. pterocephalus* of the Niagara strata of Wisconsin was so unexpected, that it seemed best to make a note of this fact. This has been the occasion of the collection of the few notes here presented.

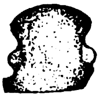

Fig. I.
Illænus (Nileus) minnesotensis, n. sp.

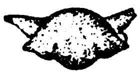

Fig. II.
lænus herricki, n. sp.

Fig. III.
Illænus ambiguus. Foerste.

ILLÆNUS (NILEUS) MINNESOTENSIS, *sp. n.*

Fig. I.

Glabella almost as long as it is wide, moderately convex, the anterior regions with greater curvature, the margin rounded. The facial sutures incurved both anterior and posterior to the palpebral lobes, rounding into the margin of the glabella in front and deflected laterally posterior to the palpebral lobes; the postero-lateral regions unknown. The palpebral lobes large, but small in comparison with the American species referred by Billings to the genus *Nileus*, defined from the remainder of the glabella by shallow curving depressions or grooves. The specimen figured was flattened sufficiently to display the anterior regions to fine advantage; when the curvature of these regions is increased the palpebral lobes have a somewhat more central position than figured. Greatest width, between the palpebral lobes.

Length of specimen figured 10.5 m m; width, between the palpebral lobes, 11.5 m m; between the antero-lateral angles, 9.5 m m; convexity, 3 m m.

Compared with *Nileus macrops*, *Bill.* and *N. scrutator*, *Bill.* the palpebral lobes are much smaller; compared with *N. affinis*, *Bill.* the lobes are smaller and further removed from the anterior margin of the glabella.

Locality and position. Trenton Group, Minneapolis, Minnesota, collected by Prof. C. L. Herrick. Type in the cabinet at Denison University.

ILLÆNUS HERRICKI, *sp. n.*

Fig. II.

Head very convex, especially from the anterior to the posterior margin, much broader than long, this appearance increased by the wing-like movable cheeks.

Glabella broad, its width equaling almost five-thirds of its length. Anterior and lateral margins forming a broad, even curve. Posterior margin indented forming three lobes, the middle lobe being much broader than the others and extending posteriorly in a prominent curve. The dorsal furrows dividing these lobes are almost parallel, distinct at their origin, becoming extinct before reaching the middle of the glabella.

The characteristic feature of this species is a second series of furrows within the dorsal furrows, slightly curved, faint, but usually readily distinguishable. The fixed cheeks become attenuated laterally merging into the palpebral lobes, which are rather pointed.

Movable cheeks extending diagonally in an antero-lateral direction, which suggests the appearance of wings, as denoted by the name of its Upper Silurian congener; becoming attenuated, almost pointed.

Eyes sharply defined from the movable cheeks by deep grooves, decidedly raised above their area, giving the eyes a bulging appearance.

Rostrum, only the anterior portion seen, showing the usual groovings.

The surface of the entire specimen more or less marked by minute pits, where the exterior crust is well preserved.

Length of specimen figured 7.5 m m; width, between the extremities of the movable cheeks, 15 m m; between the

palpebral lobes, 12.5 m m; between the dorsal furrows, 5.7 m m; between the secondary furrows, 2.6 m m; convexity, 4 m m. Large specimens are found, the largest at hand having a length of 9.2 m m.

Compared with *I. pterocephalus*, *Whitf.* it is much smaller, the dorsal furrows are not inclined towards each other at so great an angle, but usually appear almost vertical and parallel; the movable cheeks are much more attenuated. These two species coming from such different geological horizons display a striking resemblance in their general form.

Locality and position. Trenton Group, Minneapolis, Minnesota, collected by Prof. C. L. Herrick. Type in the cabinet of Denison University.

ILLÆNUS AMBIGUUS, FOERSTE.

Fig. III.

Glabella regularly accurate from front to base; the anterior border joining the facial sutures with a neat curve; the facial sutures deeply incurved anterior to the palpebral lobes; the palpebral lobes prominent, the lateral edges defined by a broad curve; the postero-lateral regions unknown. Occipital furrow less distinct along the middle, supplied with a shallow upward extension at this point, containing a distinct granule. An indistinct ridge extends from the granular to the anterior margin. The palpebral lobes are strongly defined posteriorly. Dorsal furrows deep posteriorly, suddenly becoming indistinct near the anterior regions of the palpebral lobe, then scarcely distinguishable, terminating in pits containining a granule. Anterior to these pits and nearer the lateral margin is another granule.

Length, 19 m m; width between the palpebral lobes, 22 m m; between the antero-lateral angles, 19.7 m m; between the incurved portions of the facial sutures, 17.5 m m.

When this specimen was first studied it was considered a new species related to *I. ambiguus.* Its anterior margin is more rounded than is usual in that species, and the width between the antero-lateral angles is relatively smaller.

It is at least interesting as representing a slightly different phase of *I. ambiguus*, which usually has a broader, less curved

anterior. These distinctions alone, however, could scarcely be ranked as specific.

Locality and position. Mifflintown, Pa., in the Niagara Group, Rogers' Collection. Museum of the Boston Society of Natural History, No. 5074.

ILLÆNUS INSIGNIS, *Hall.*

Pl. XV. Fig 5, *Ohio Pal. Vol. I.*

The Ohio species from the Guelph series were referred by Meek doubtfully to *I. insignis*, the chief trouble being due to the form of the pygidia. The glabellæ are variable as might be expected in a species of considerable distribution, but numerous specimens from Ohio leave no doubt of their identity with the glabellæ from Wisconsin. The association of pygidia in the Wisconsin specimens was chiefly a matter of conjecture. In Ohio we have been more fortunate in finding specimens with the pygidia attached. Figure 14 of plate 22, in the twentieth Regents Report of the New York State Cabinet, therefore does not belong to *I. insignis*, and the glabella is the only available portion for identification. Taking the pygidia of the Ohio specimens as typical, we find that *I. insignis* and *I. ambiguus* are closely related, as was suspected from the very first. *I. ambiguus* is found in the base of the Niagara series in Ohio, here known as the Clinton group, *I. insignis* is found at the very summit of the same, the equivalent of the Guelph strata. As *I. Herricki* is the fore-runner of *I. pterocephalus*, so *I. ambiguus* is the fore-runner of *I. insignis*. The last two species are readily distinguished by the greater width of the glabellæ between the antero-lateral margins or angles in *I. ambiguus*, and the consequent greater prominence of these angles. The pygidia associated by Hall with *I. insignis* are also found in Ohio, but not in connection with the glabellæ referred to *I. insignis*. I learn from Lieut. A. W. Vogdes that Prof. Whitfield considers the association of the pygidia by Prof. Hall as incorrect. I gladly quote his authority as far as the occasion gives me warrant.

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

THE FIRST ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1872. 112 pp., 8vo.; with a colored map of the state. By *N. H. Winchell*. Published in the Regents' Report for 1872. Second edition identical.

THE SECOND ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1873. 145 pp., 8vo.; with illustrations. By *N. H. Winchell* and *S. F. Peckham*. Published in the Regents' Report for 1873. Out of print.

THE THIRD ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1874. 42 pp.; 8vo.; with two county maps. By *N. H. Winchell*. Published in the Regents' Report for 1874. Out of print.

THE FOURTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1875. 162 pp., 8vo.; with four county maps and a number of other illustrations. By *N. H. Winchell*, assisted by *M. W. Harrington*. Also in the Regents' Report for 1875. Out of print.

THE FIFTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1876. 248 pp., 8vo.; four colored maps and several other illustrations. By *N. H. Winchell;* with reports on Chemistry, by *S. F. Peckham;* Ornithology by *P. L. Hatch;* Entomology, by *Allen Whitman;* and on Fungi, by *A. E. Johnson*. Also in the Regents' Report for 1876. Out of print.

THE SIXTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1877. 226 pp., 8vo.; three geological maps and several other illustrations. By *N. H. Winchell;* with reports on Chemical Analyses, by *S. F. Peckham;* on Ornithology by *P. L. Hatch;* on Entomology, by *Allen Whitman;* and on Geology of Rice county, by *L. B. Sperry*. Also in the Regents' Report for 1877. Out of print.

THE SEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1878. 123 pp., 8vo.; with twenty-one plates. By *N. H. Winchell;* with a Field Report, by *C. W. Hall;* Chemical Analyses, by *S. F. Peckham;* Ornithology, by *P. L. Hatch;* a list of the Plants of the north shore of Lake Superior, by *B. Juni;* and an Appendix, by *C. L. Herrick* on the Microscopic Entomostraca of Minnesota (twenty-one plates). Also in the Regents' Report for 1878.

THE EIGHTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1879. 183 pp., 8vo.; one plate (Castoroides). By *N. H. Winchell*. Containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, and descriptions of new species of brachiopoda from the Trenton and Hudson River formations; with reports on the Geology of Central and Western Minnesota, by *Warren Upham;* on the Lake Superior region, by *C. W. Hall;* lists of Birds and of Plants from Lake Superior, by *Thomas S. Roberts;* Chemical Analyses, by *S. F. Peckham;* Report by *P. L. Hatch*, and four Appendixes. Also in the Regents' Report for 1879 and 1880. Out of print.

THE NINTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1880. 392 pp., 8vo; three Appendixes, two wood cut illustrations and six plates. By *N. H. Winchell*. Containing field descriptions of 442 crystalline rock samples, and notes on their geological relations, from the northern part of the state, new brachiopoda, the water supply of the Red River valley, and simple tests of the qualities of water; with reports on the Upper Mississippi region, by *O. E. Garrison;* on the Hydrology of Minnesota, by *C. M. Terry;* on the Glacial Drift and its Terminal Moraines, by *Warren Upham;* Chemical Analyses, by *J. A. Dodge;* a list of the Birds of Minnesota, by *P. L. Hatch;* and of the Winter Birds, by *Thomas S. Roberts*. Also in the Regents' Report for 1879 and 1880.

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THE ELEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1882. 219 pp., 8vo.; with three wood cut illustrations and one plate. By *N. H. Winchell.* Containing a report on the Mineralogy of Minnesota, and a note on the age of the rocks of the Messabi and Vermilion iron districts; with papers on the crystalline rocks of Minnesota, by *A. Streng* and *J. H. Kloos;* on rock outcrops in Central Minnesota and on Lake Agassiz, by *Warren Upham;* on the iron region of Northern Minnesota, by *Albert H. Chester;* Chemical Analyses, by *J. A. Dodge;* and an Appendix containing Minnesota Laws relating to Mines and Mining, abstracted by *C. L. Herrick.* Also in the Regents' Report for 1881 and 1882.

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II. FINAL REPORT.

THE GEOLOGY OF MINNESOTA. VOL I. OF THE FINAL REPORT. 1884; xiv. and 697 pp., quarto; illustrated by 43 plates and 52 figures. By *N. H. Winchell*, assisted by *Warren Upham.* Containing an historical sketch of explorations and surveys in Minnesota, the general physical features of the state, the building stones, and the geology of Houston, Winona, Fillmore, Mower, Freeborn, Pipestone, Rock and Rice counties, by *N. H. Winchell;* the Geology of Olmsted, Dodge and Steele counties, by *M. W. Harrington;* and the Geology of Waseca, Blue Earth, Faribault, Watonwan, Martin, Cottonwood, Jackson, Murray, Nobles, Brown, Redwood, Yellow Medicine, Lyon, Lincoln, Big Stone, Lac qui Parle and Le Sueur counties, by *Warren Upham.* Distributed gratuitously to all public libraries and county auditors' offices in the state, to other state libraries and state universities, and to leading geologists and scientific societies; the remainder are held for sale at the cost of publication, $3.50 per copy in cloth, or $5 in grained half roan binding upon application to Prof. N. H. Winchell, Minneapolis.

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2. PEAT FOR DOMESTIC FUEL. 1874. Edited by *S. F. Peckham*.
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